

Marine Engineering

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The Shipyards

IN the general political turmoil of preparation for the presidential campaign, the claims of labor and the agricultural interests for the righting of their real or imaginary wrongs seem to take precedence over all else, if the amount of noise made by the claimants may be taken as a criterion of the strength of the demand.

It is most interesting to note that the recent rise in price of grain and corn has done more for the farmer than could possibly be accomplished by the most radical proposals of the political witch doctors, and while it emphasizes the speculative element which necessarily characterizes all business dependent upon climatic conditions, it is equally clear that, in the long run, the demand for food stuffs is bound to throw the balance in the farmer's favor.

The American shipbuilder is in quite a different situation. With naval work, so far as he is concerned, apparently at an end, with no such duty to offset the demands of labor and high material costs as protects every other industry in the country, and with a considerable element in Congress apparently bent upon doing everything possible to hinder and interfere with private enterprise in shipbuilding and repairing, the break is constantly against the shipbuilder and unless public opinion is aroused to the seriousness of the situation, there is not only a possibility, but a very real and serious danger, that the building of seagoing vessels in this country will become, to all practical purposes, a lost art.

While it is quite true that so long as the present laws continue in effect there will be a potential demand for American ships in the coastwise and intercoastal trade, indications are not wanting that there is a considerable number of our national legislators, who would welcome the opening of the coastwise trade to foreign vessels with the consequent and inevitable ruin of all the American shipyards as a triumphant exposition of the application of free trade principles. The same influences are constantly at work to throw as much work as possible to the navy yards.

While it may not be probable that these destructive policies will prevail in Washington, the danger nevertheless exists and is a very real one. That any of our legislators should not only refuse aid to the shipyards but on the other hand openly favor policies which could result only in their ultimate destruction indicates a state of mind quite beyond our ability to comprehend. However, there are such men and they are by no means confined to the halls of Congress. They will bear constant watching, for it is ever true that "Eternal vigilance is the price of safety," as well as liberty.

Among all the great commercial nations, the United States appears to be the only one whose people do not grasp the necessity of maintaining its merchant marine and private shipbuilding industry. That there is a latent interest and desire to build and use American vessels, there seems to be no doubt, but it is overshadowed by matters which appear, to the inland portion of our population, at least, of more immediate and vital importance. The opposition to shipbuilding arises, we believe, more from ignorance than from prejudice, and it would seem that an active campaign of education as regards the relation of shipbuilding and shipping to the country's ultimate prosperity and success as a participant in the trade of the world is the greatest present need.

We are among those who believe that this country will eventually build up its merchant marine and kindred industries as a result of direct economic pressure, if for no other reason, but this is a matter of the future. The pressing needs of the present situation are what we are vitally concerned with; the preservation of what, at no distant time, will come to be recognized as one of the country's essential and vitally important industries.

An operating shipyard is far from being merely a collection of building ways, shops and tools. The really essential factor, that which gives it life and ability to produce results is the organization by which it is run, and a shipyard organization is not made in a day, or an expert shipbuilder produced by a few weeks of "intensive" training. Without the

leavening of practical naval architects, engineers and ship-builders distributed among them, the emergency yards of the late war could not have operated—even as it was, the only vessels which actually saw service before the armistice was signed came from the old and well established yards, notwithstanding the fact that their organizations had been drawn upon in the building up of the new yards.

The men who furnished the brains and backbone of our great feat of ship production were what they were as the result of lives spent in the business and which had been developed by hard study and application, not only in this country, but in foreign schools and shipyards. Unless something is done to preserve and encourage the industry these men must, of necessity, drift into other lines of work. Practically no one is being trained to take their places and, if the process is allowed to proceed unchecked, the next emergency which arises, and sooner or later it must arise, will find us not only unprepared but helpless.

The Point of View

SINCE, in foreign eyes, American vessels lost their usefulness with the closing of the war, the various shipping papers abroad, particularly in England, have devoted considerable space to criticising the attempts of this country to utilize its vast war-created fleet by entering into foreign trade.

It is harder for nations even than for individuals to follow the practice of "put yourself in his place" and to try to view matters of international controversy from an opponent's standpoint. Even allowing, however, for the difficulty of any active participant in an argument getting an impartial view, it does appear to us that the foreigners are a trifle too ready with their adverse comments on American shipping activities, and have given little or no consideration to the circumstances which have led up to and surround the shipping situation in this country.

Had there been no world war the present government fleet would not have come into existence, but there would have been, nevertheless, an increase in American shipping with the opening of the Panama Canal and indications were not wanting in 1914 that such a movement was already under way. Furthermore, it seems reasonable to assume that naval construction would have gone forward—in at least as great a volume as had obtained during the years immediately preceding the war. There were abundant signs that the country had come to consider a modern and efficient battle fleet a necessity and that because of the new intercoastal trade the merchant fleet was on the eve of a material increase, both in numbers and tonnage.

Anything approaching orderly and stable growth or development was, of necessity, entirely forgotten in the struggle to meet the requirements of conflict but while the country emerged from the war with a merchant fleet in being and under construction, far in excess of its normal requirements, it had had demonstrated to it, in no uncertain manner, the need of a sizeable and efficient fleet, and, furthermore, the pressing call of the moment, short lived as it eventually proved to be, was for more ships. There seemed to be no limit of price in the face of this demand and it is not to

be wondered at, certainly not a matter for blame, that a large number of ships commenced during the war were carried on to completion after the armistice had been signed.

Beyond the demonstrated fact of their necessity, the country at large gained little knowledge of ships, as a result of the war. It was quite aware, however, of the enormous sums spent in their construction and demanded that some return should come from the investment. Under these circumstances, the obvious path for the Shipping Board to follow lay in the direction of active operation of the vessels, by means of sale to private interests, if possible, and, failing this, by government operation through the medium of the Emergency Fleet Corporation.

The management of this great fleet of merchant vessels, unprecedented in numbers and total tonnage, constituted a problem which could well have given pause to an experienced ship operator, and it was apparent that the Fleet Corporation fell far short of fulfilling this specification. The difficulties of the situation became plainly apparent immediately the reaction in ocean commerce set in, and there was a general demand that the government should go out of the shipping business at once but the act which created the Shipping Board also requires that it maintain American ship service on essential ocean routes. The Board is left no choice in the matter and the present government-controlled lines to foreign ports are the result.

While it is no doubt a fact that the inherent shortcomings of government operation make it well nigh impossible to reach the maximum of efficiency, it must be admitted that, on certain routes, a fair degree of success has been attained and in actual ship operation a steady and material improvement has been made. Certain it is, that if the mandates of the Jones Act are to be followed, and the flag kept on the high seas, the activities of the Shipping Board must continue, at any rate until there is a very material improvement in general trade and some acceptable means is found of overcoming the differential against privately owned American vessels engaged in overseas trade.

Such, in brief, is the general situation, and its reaction abroad is an interesting study. In certain quarters, parties with particularly short memories appear to take the view that the Emergency Fleet was something specially created to worry and annoy all European shipping interests, a trespasser and interloper in a field which they have come to look upon as their own particular and exclusive property, and no condemnations seem too severe, or sneering comment too cutting, to be applied to American shipping.

It is not so, however, with really worthwhile opinion. The best British papers, so it seems to us, strive to take a fair, and, as far as is possible, an unprejudiced view of the situation. To them, conflict between the two great English speaking peoples is unthinkable and they believe America should do its full share in the maintenance of a naval force of such magnitude that its absolute control of the seas will ever be beyond question.

All true and broad minded Americans will, we think, agree with the conclusion of a recent article in the *Liverpool Journal of Commerce*, which says: "An efficient U. S. Navy, working in conjunction with the British Navy, is the best

guarantee of the peace of the world, and we can only hope that the United States will shoulder its burden and live up to the strength allowed it by the Washington Disarmament Treaty." While our contemporary is evidently four square with us as to the necessity of sustained U. S. naval strength and efficiency, it is not clear as to how the desired condition is to be maintained.

It is just here that the shoe pinches. An efficient navy can exist only with the backing of an active naval reserve. The British paper has been at pains to dwell on this fact and in an editorial has expressed its friendliness, in no uncertain terms, for the naval reserve bill which was brought before Congress just before adjournment. But a naval reserve implies a merchant marine—and this is another matter. While we believe that our British friends are quite sincere in their objections to certain proposals which have been made for developing our merchant marine and while, from their point of view, these objections are doubtless well taken, it appears, rather clearly, that similar opposition will be developed to *any* proposition having in view the building up of overseas trade in American vessels.

We find no fault with British interests for looking askance on any movement which tends to increase the competition which they have to meet in certain avenues of trade, but their very anxiety to hold and to expand their own business should, it seems to us, temper the spirit of criticism accorded to foreigners, who, after all, are moved by the same spirit as themselves. One has but to look back to the Royal Mail subsidies of 1840 and 1850, or the building of the great Cunard ships, to realize that Great Britain has never failed her shipping in times of threatened stress. She should not, we think, be too critical of the aspirations of others in the same field, particularly as one of the principal results hoped for will be, as she herself freely admits, a guarantee of world peace.

Hudson River Steamboats

ASIDE from the interest aroused by the recent completion of such a vessel as the *Alexander Hamilton*, this event naturally turns one's mind to the great part which has been played by the Hudson River in the development of steam navigation in this country.

While it is true that the first American experiments in the propulsion of vessels by steam power were not undertaken on the Hudson, the first attempt to use steam propelled vessels commercially was made on this river and the development of the characteristic American river steamboat has very largely resulted from the extensive business and keen competition which has characterized the trade on this river since colonial days.

The first steam vessel to be built in America was constructed by John Fitch at Philadelphia and had its trial in August, 1789. This boat was 45 feet long and 12 feet wide. It was propelled by a system of paddles and made about three miles an hour. Fitch built a later boat 60 feet long, 8 feet wide and 4 feet deep which made slightly better time, but his experiment could not be said to have been a commercial success.

As is very well known, the first steamboat on the Hudson

was the *Clermont*, built by Robert Fulton in 1807. This vessel was 140 feet long, 16 feet wide, 7 feet depth of hold and drew 28 inches of water. She had a Bolton and Watt "bell crank" engine with a cylinder 24 inches in diameter and 48 inches stroke. The paddle wheels were 15 feet in diameter and 48 inches face and were mounted on a cast iron shaft $4\frac{1}{2}$ inches in diameter. The boiler was of copper 7 feet in diameter and 20 feet long.

The *Clermont* made her first trip from New York to Albany in August 1807, the average speed for the entire distance of 150 miles being 5 miles per hour. She continued in service until July, 1814.

John Stevens of Hoboken completed a steamer called the *Phoenix* a few weeks after the *Clermont* came out, but as the legislature of New York State had granted to Fulton a monopoly of steam navigation on the Hudson River the *Phoenix* was taken around to Philadelphia, thus being the first steamboat to go to sea. It should also be noted that this vessel had American built machinery.

During the period from 1808 to 1820, the growth of steam navigation on the Hudson was restricted by the Fulton monopoly. There are records of twelve steamers in operation at one time or another during this period.

In 1824, the United States Supreme Court removed all barriers to free navigation of the rivers of the United States by "boats propelled by fire or steam" and the use of steamers on the Hudson subsequently increased.

The "skeleton working beam," entirely of iron, was first introduced by Robert L. Stevens in 1822 on the ferryboat *Hoboken*.

It is interesting to note that from 1825 to 1829 a considerable portion of the passenger traffic on the Hudson was carried on by barges, towed by steam towboats and known as "safety barges." They were advertised as saving the passengers from the danger of fire and steam. Under favorable conditions, they made from 8 to 9 miles an hour. By the increase in speed and accommodations of the steamboats, traffic was drawn away from the barges and they were discontinued.

The Hudson steamboats early developed what at the time was considered a very high speed. In 1837 the *Rochester* made the run from Albany to New York at the rate of about 15 miles an hour. This boat had a cylinder 43 inches in diameter and 10 feet stroke, and at full speed made about 27 revolutions per minute. In the 60's, speeds of 20 miles an hour were reached.

After 1830, the steamers rapidly increased in numbers and in size and there was keen competition between the different river lines. A very distinct type of vessel was developed which continued in use until comparatively recent years and which still persisted, even after the introduction of iron hulls and high pressure steam. Today many of the Hudson River steamers have features inherited from their early forerunners.

The following particulars of some of the famous Hudson River steamers of the middle of the last century, taken from Morrison's "History of American Steam Navigation" are of interest as illustrating the development of these vessels:

Name	Date	Length	Type of Engine	Size of Cylinders
North America	1840	230'	Beam	48" x 11'
Nragard	1845	265'	Beam	60" x 11'
Alida.....	1847	276'	Beam	62" x 12'
Francis Skiddy	1850	325'	Beam	70" x 14'
Daniel Drew	1861	244'	Beam	68" x 10'
Mary Powell	1861	286'	Beam	62" x 12' (increased to 72" x 12' in 1874)
Saint John	1864	393'	Beam	85" x 15'
Drew	1867	366'	Beam	81" x 15'

The Peoples' Line, the forerunner of the present Hudson Navigation Company, was founded as an association of the owners of the larger and better equipped boats in 1840, an incorporated company being formed at a later date. Originally operating both day and night boats, the company sold out its interests in the former in the 'sixties and since that time has confined its operations to the night lines between Troy, Albany and New York.

The present Day Line had its beginning in the purchase in 1860, of the *Alida*, by Alfred Van Santvoord, who used the vessel for excursions and through passenger traffic. In 1863, Commodore Van Santvoord, in association with some others, bought the *Daniel Drew* and the *Armenia*, thus obtaining control of the entire day line business which is today so ably carried on by his descendants. The present Day Line was incorporated in 1879, the name being changed to Hudson River Day Line in 1899.

Starting with the advent of the little *Clermont*, the past hundred years has witnessed, on the Hudson, the entire replacement of other means of commercial navigation by steam, and a similar transformation, very nearly as complete, has taken place in the merchant fleets of the world.

While the internal commerce of our country has, in the same period, come to be handled, in most part, by the railroads, the actual volume of trade going to the river steamers has reached proportions little dreamed of by Fulton and his associates, and with the constant growth of production and the steady and ever increasing demand for more and better means of internal communication, it seems certain that, in the near future, the proportion of the country's transportation business handled by the inland water ways will increase as well.

Recent Aids to Navigation

THE science of astronomical navigation and the development of methods of determining a ship's position by observations of the sun and stars reached a high degree of perfection many years ago. The study of spherical trigonometry, together with increasing knowledge of astronomy and the motions of the heavenly bodies, determined the theory underlying practical navigation long before mechanical skill had advanced to the point of making possible instruments of sufficient delicacy to put this theory into absolutely accurate and successful practice. The invention of the chronometer, about the middle of the 16th century, formed the basis of the successful application of the principles of navigation, and since that time, the development of the art of locating a ship's position by observation has been mainly along the lines of perfecting the mechanical detail and accuracy of the instruments used.

Unfortunately, however, observations alone are not suf-

ficient, at all times, to accurately fix a ship's position, and in much of his work the navigator has to depend upon an estimate of the actual speed and direction of the vessel's course over the sea's bottom to find her position. All estimates of this sort are, of necessity, liable to error and independent checks are essential to verify the positions determined by log and compass.

With the possibility of observation of sun or stars eliminated by thick or cloudy weather, the navigator is dependent, in checking his position, upon soundings or upon bearings obtained by submarine signal or radio.

Radio or submarine signals may be received while under way and at frequent intervals. The latter is, however, restricted to a relatively short distance from the sending station while with the former accurate results are dependent upon several operators, in addition to those on the vessel herself, and there seems to be a considerable possibility of error creeping in, although under favorable conditions, results of entirely satisfactory accuracy are obtained.

The position of a ship may also be determined, with practically absolute accuracy, by successive depth soundings, but while the sounding machine has greatly facilitated these measurements, physical contact with the bottom is still necessary, causing more or less delay, and in any event not approaching a continuous record of depths.

The most important and, to the lay mind, spectacular improvements have been made in these various aids and checks to navigation by dead reckoning, during the past few years. The gyro-compass with its elimination of the errors due to variation and deviation of the magnetic needle, the submarine bell and later vibrator, making possible the taking of bearings in foggy weather, the application of radio telegraphy, already the most important factor in saving life at sea, to direction finding and bearing determination, and finally the sonic sounder, for determining depth from a moving vessel, without physical contact with the bottom of the sea, are all at the service of the navigator.

In a way the most sensational of recently devised aids to navigation, the sonic sounder is, in principle, most simple. In effect it is an apparatus for determining the length of time required by a sound of very short duration made at a ship's bottom to strike the ocean floor and be reflected back to the ship. Investigations along this line have been going forward for several years, on both sides of the Atlantic. Exhaustive experiments have been carried on by our Navy, and, although its work has been mainly confined to deep waters, most remarkable and important results have been obtained in both the Atlantic and Pacific from destroyers running at high rates of speed.

It has remained for the Submarine Signal Corporation of Boston to work out a practical means of applying sonic sounding to all depths of water, and in their so-called fathometer, this end has evidently been successfully accomplished.

The fathometer suggests many other possibilities in the way of applying sound detection to navigation and it may well come about that, in the near future, the navigator, through its use, will be made aware of the presence of icebergs and derelicts and thus the last great danger to navigation will have been overcome.

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Shipping Board Orders Port Differential Inquiry

By Harold F. Lane

WASHINGTON, D. C.

ONE of the most important steps ever undertaken by the Shipping Board in its character as a rate-regulating body, somewhat similar to the Interstate Commerce Commission in its relation to railroads, was instituted on August 5 when the board adopted a resolution providing for the initiation of a proceeding of inquiry and investigation into the rates and differentials from the Gulf, South Atlantic and North Atlantic ports of the United States to the United Kingdom, Baltic-Scandinavian, Continental European, Portuguese-Spanish, Mediterranean and Adriatic, Black Sea and Levant ports. This was the result of the filing of complaints by Charleston and Jacksonville attacking the ocean rate differentials applied to those ports, by the port of Norfolk attacking the practice of maintaining parity rates on certain commodities from Atlantic and Gulf ports, and the filing of intervening petitions by various ports in those cases. All steamship lines operating between Atlantic and Gulf ports and United Kingdom and European ports were made respondents and the complaints were consolidated with the investigation proceeding.

A statement issued by the board said that the present differentials are considered by many as discriminatory against the Gulf and South Atlantic. These differentials were adopted by the steamship conferences about 1920, when rates were materially higher than at the present time. For illustration, in 1920 the rate on cotton from Gulf ports to the United Kingdom was \$1.82½, whereas the present rate is 62½ cents; on cottonseed cake the 1920 rate was 80 cents and the present rate is 27 cents; on hides the 1920 rate was \$2.65 and the present rate is \$1.40. Notwithstanding the heavy drop in rates, the board said, the differentials have remained the same on most of the commodities moving in these trades, presumptively to the great disadvantage of the Gulf and South Atlantic ports. In the case of cotton the differential is 25 cents to all Continental European and Mediterranean ports, and is 20 cents to the United Kingdom. "Evidence is before the board," the statement continued, "that there is widespread dissatisfaction with the present differential situation, and Commissioner Thompson's resolution, by virtue of authority vested in section 22 of the shipping act of 1916, orders an investigation to determine whether or not the practice of the carriers results in undue prejudice against the Gulf and South Atlantic ports. Any unjust discrimination between ports, in violation of sections 16 and 17 of the shipping act of 1916, if found to exist, can be corrected by order of the Shipping Board to the carriers to so adjust their rates as to place all the ports on an equitable and non-discriminatory basis."

Copies of the order were served on approximately 160 steamship lines. While the board has not decided whether or not hearings in the proceedings will be confined to Washington, it is expected that requests will be made that hearings outside of Washington be held at least at one port in each of the three districts involved—North Atlantic, South Atlantic and Gulf. Hearings probably will not be started until some time in October. The text of the official order follows:

It appearing that rates on freight traffic moving from north Atlantic ports of the United States to United Kingdom, Baltic-Scandinavian, Continental European, Portuguese-Spanish, Mediterranean and Adriatic, Black Sea and Levant ports are generally lower by certain differentials than rates from south Atlantic ports of the United States to the same foreign ports, and that rates from said north Atlantic and south Atlantic ports are lower by certain differentials than rates from gulf ports of the United States to the aforesaid foreign ports, and that said differentials have been and are maintained primarily through the medium of steamship conference organizations;

It further appearing that protests against the maintenance of differentials against the south Atlantic and gulf ports of the United States in favor of the north Atlantic ports of the United States to the foreign ports herein-

above referred to have been lodged with the United States Shipping Board, and that a complaint known as formal docket No. 23 has been filed with the board by the Port Utilities Commission of Charleston, S. C., et al. vs. The Carolina Company et al., assailing as unlawful the practice of maintaining higher rates from said south Atlantic than from said north Atlantic ports to the foreign ports above described; and that a complaint known as formal docket No. 25 has been filed with the board by the Norfolk Port Commission assailing as unlawful the practice of maintaining on certain commodities parity rates from north Atlantic, south Atlantic and gulf ports to said foreign ports; and,

It further appearing that the inter-relationship between the rates from the aforesaid ports of the United States makes it essential that the whole situation with respect to the maintenance of said port differentials and parities be considered; and that an investigation by the board will be in the interest of the public;

It is ordered that a proceeding of inquiry and investigation be, and it is hereby, instituted by the United States Shipping Board into the rates and charges applicable on freight traffic moving from north Atlantic, south Atlantic and Gulf ports of the United States to United Kingdom, Baltic-Scandinavian, Continental European, Portuguese-Spanish, Mediterranean and/or Adriatic, Black Sea and Levant ports into the practice of maintaining on certain commodities differentials in favor of north Atlantic and against south Atlantic and gulf ports, and differentials in favor of north Atlantic and south Atlantic ports against gulf ports of the United States, and into the practice of maintaining on certain other commodities parity rates from said United States ports to the same foreign ports, with a view to determining whether said rates, charges and practices are unduly prejudicial to, or unduly preferential to, particular ports, persons, or traffic, or unjustly discriminatory in violation of sections 16 and 17 of the shipping act, 1916, or otherwise are unlawful, and to make such findings and order or orders as may appear proper in the premises; and,

It is further ordered that the complaint of the Port Utilities Commission of Charleston, S. C., et al. vs. The Carolina Company et al., known as formal docket No. 23, and the complaint of the Norfolk Port Commission vs. Algerian American Line et al., known as formal docket No. 25, be, and they are hereby, consolidated with and made a part of this proceeding; and,

It is further ordered that all common carriers by water subject to the United States Shipping Board and operating from north Atlantic, south Atlantic and/or gulf ports of the United States, to United Kingdom, Baltic-Scandinavian, Continental European, Portuguese-Spanish, Mediterranean, and/or Adriatic, Black Sea and Levant ports be, and they are hereby, made respondents to this proceeding; that a copy of this order be served upon each of said respondents whose names appear in the appendix hereto or may be hereafter added thereto, and that notice of this proceeding be given to the public through the press; and,

It is further ordered that this proceeding be assigned for hearing before Examiner H. E. Mangum, at such times and places as may be hereafter directed.

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FLEET CORPORATION LOSSES

The Fleet Corporation's monthly financial statement for June reflects an operating loss of \$3,620,734.80 for that month, as compared with \$3,940,121.86 for the month of May, or a reduction of \$319,387.06, according to a statement issued by the Shipping Board.

The status of the active fleet at the close of business July 19 was announced as follows:

Steel cargo vessels under assignment to traffic dept.....	296
Steel passenger vessels under assignment to traffic dept.....	20
Steel cargo vessels under B/B charter to private companies.....	2
Steel refrigerator vessels under B/B charter to private companies.....	1
Steel cargo vessels under loan to government agencies.....	2
Steel tankers under assignment.....	17
Steel tugs under assignment (tug agreement).....	1
Steel tugs under bareboat charter.....	3
Steel tugs under assignment (operating dept.).....	6
Wood tugs under bareboat charter.....	2
Wood tugs under assignment (E. F. C. for service and operating dept.).....	11
Wood barges under assignment (operating dept.).....	2
Total fleet in operation.....	363

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ARE AMERICANS UTILIZING AMERICAN SHIPS?

With a view of making a nation-wide survey of the extent to which American merchant ships are being utilized by Americans, T. V. O'Connor, Chairman of the Shipping Board, is writing personal letters to over 10,000 American exporters, importers and all others engaged in foreign commerce, asking whether they are using American ships.

"The object of these letters," Chairman O'Connor said, in making public a sample of this correspondence, "is to find out exactly how American producers and shippers stand regarding our ships. When replies to the questions I am asking in the letters are received we should have an honest expression from that element of the American public which uses ocean-going vessels for the shipment of their products."

The specific questions which Chairman O'Connor asks in the letter are as follows:

1. If foreign flag vessels are used by you, what advantages, if any, do you derive from their use as against American flag vessels?
2. Is it your policy to direct the method by which your raw or manufactured materials from foreign sources shall be transported, and could you designate American vessels for such importations?
3. Could you advise that you will insist that at least 51 percent of the

export or import business under your control be transported in American vessels?

4. May we count upon your co-operation in directing your foreign shipments by American vessels?

Lloyd's

FOR those of the shipping community whose work brings them frequently in touch with Lloyd's Register of Shipping, two events have recently occurred, of more than ordinary interest—one, the awarding of two additional scholarships in naval architecture, at the Massachusetts Institute of Technology and the University of Michigan, respectively, by the American Committee of Lloyd's Register; and the other, the receipt, at the New York office of the Register, of a valuable collection of old prints, reminiscent of the early days of Lloyd's in London.

So far as the scholarships are concerned, they are but an additional reminder of the active and important part which the time honored classification society has played in the



Fig. 1.—The Royal Exchange, London, Where Lloyd's First Permanent Quarters Were Established in 1774

American shipbuilding industry for the past twenty years. Coming as they do, they seem to us to form a peculiarly significant contribution to the upbuilding of marine knowledge in this country.

The prints, or more particularly, the period and events to which they have reference, are of more general interest, and, for all who are in any way connected with shipbuilding or shipping, deserve more than a passing mention.

The average shipping man, in this country, at any rate, when speaking of "Lloyd's," has reference usually to Lloyd's Register of Shipping. The parent body, notwithstanding its tremendous influence upon shipping affairs the world over—the Corporation of Lloyd's—is less well known here, except in circles directly concerned with the business of marine insurance.

Although the Corporation of Lloyd's may be said, today, to constitute the hub of the marine insurance business, and as such to exert a greater influence upon the shipping affairs of the world than any other privately controlled organization, its origin was most humble and unpretentious. It can, in fact, be traced to a riverside coffee house in London, where seafaring and shipping men met and discussed their various experiences.

Just when Edward Lloyd founded his coffee house, and in so doing entered his name on the records of shipping's hall of fame, is not definitely known, neither is there much on record in regard to the man himself. It is certain, however, that the coffee house was in existence in 1688. At this date it was located in Tower street, near the Thames, but later it was removed to a location nearer the business center of the



Fig. 2.—Caricature of Lloyd's Coffee House, Made in 1798

city, where it became a rendezvous for merchants, underwriters and brokers seeking information on marine matters in general, and particularly in marine insurance. It was here that the first Ships' Register or list was systematically kept. Apparently Lloyd was a man of more than ordinary energy and ability, as he improved his service as a Marine Intelligencer by establishing a series of correspondents in home and foreign ports and publishing a paper devoted to marine news and called *Lloyd's News*. This paper was the forerunner of the present *Lloyd's List* which can claim to be the oldest newspaper in existence, with the single exception of the *London Gazette*.

In 1770 the underwriters and brokers frequenting Lloyd's Coffee House formed themselves into an association, taking the distinctive name of "Lloyd's," and in 1774 moved into

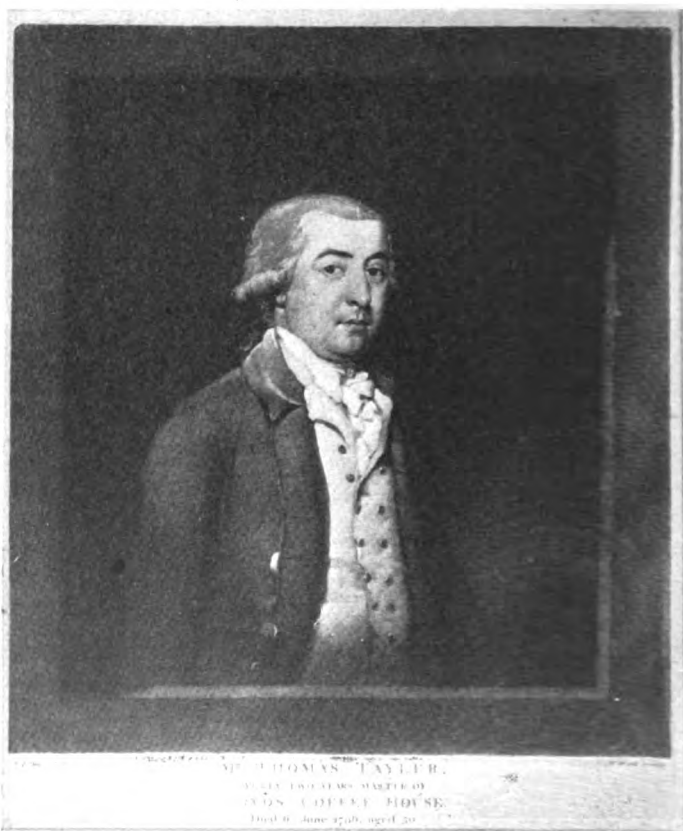


Fig. 3.—Thomas Tayler, Master of Lloyd's in 1798

their first permanent quarters in the Royal Exchange (Fig. 1). These rooms consisted of a large subscribers' room and two coffee rooms. One of these latter rooms is shown in caricature in the quaint illustration (Fig. 2) made in 1798. The "Master of Lloyd's" at this time was one Thomas Taylor (Fig. 3), apparently a man of some considerable importance in the marine circles of London.

The nature of the business transacted by "Lloyd's" resulted in the devotion of special attention to the obtaining of reports and surveys to determine the condition and insurability of vessels.

From the earliest days of the Coffee House the necessity of having some such record seems to have been recognized by the underwriters and accounts of such vessels as were likely



Fig. 4.—Present Headquarters of Lloyd's Register of Shipping in Fenchurch Street, London

to be offered for insurance were kept by earlier frequenters of the place. The keeping of a ships' list or register has already been alluded to. Commencing with manuscript records, the first printed register was published in 1726.

At first carried on by the parent corporation the business of inspection, survey and recording of ships' particulars rapidly increased to the extent that a separate organization for this work became necessary and, in 1834 Lloyd's Register of Shipping, as a separate entity, was established.

For many years, the business of the Register of Shipping was carried on from headquarters in White Lion Court, Cornhill, London, but the steadily increasing demands of the rapidly expanding business eventually necessitated a move to more commodious quarters, and the building in Fenchurch street (Fig. 4) was constructed in 1901 and has since been occupied by the Register.

Thus, in very meager outline, is recorded the beginning and growth of one of the great commercial institutions of the world. From a small group of merchants, meeting in a coffee room to adjust their personal ventures in ships, has grown a corporation having a preponderating influence in all marine insurance and from the first attempts to systematically examine and record the condition of mercantile vessels has come the great registration society whose rules form the basis of the construction of nearly 60 percent of the world's present fleet of commercial vessels.

Will Steam Engineers Man the New Motorships?

By A. B. Newell

WITH the rapidly increasing popularity of motor vessels there is some speculation, and perhaps not altogether groundless fear, as to what the situation will be with regard to motorship engineers, should this type of vessel become so popular in America that an extensive building or conversion program be taken up by shipowners.

The present Shipping Board plan, when carried out, will no doubt make the situation somewhat more acute than it has been, this more especially in view of the fact that the converted ships will all be single screw jobs with larger power units than the average Diesel engine builder of this country has turned out.

I would be very well pleased with myself if I could present a workable means of supplying capable motor engineers. By this I do not mean to supply just men with motor licenses, for there is a host of such floating about at present. With a view to helping slightly I will explain how various means have been employed to produce engineers for our present fleet of motorships. Strangely enough, although many admirable plans have been presented for "helping" steamship engineers to make the change, the ones who have really done the most toward solving the problem are the engineers themselves.

On the start a large number of small motorboat engineers went to sea as the result of enticing offers of large pay made during the war. Quite a number of these men took hold with a will, learned to handle large power units and became successful in their work.

At the close of the war the Navy released a large number of machinist mates, from the submarines and subchasers, who were experienced in the operation of internal combustion engines. As a natural course of events a portion of these drifted into merchant service.

These two sources of supply shortly exhausted themselves only to be followed by the slump in shipping which threw a large number of steamship engineers out of employment.

In casting about for a means of profitably employing themselves a portion of these commenced to see the possibilities of motor work. They secured berths as junior or senior motor men—wipers or oilers—on motor vessels, or went to work in plants where Diesels were being built and in this way served the time required to give them motor licenses. It goes without saying that many of them fell into the new work with but little difficulty.

In a few instances steamship lines cooperated with Diesel engine builders in training engineers, but some became disgusted because the men whom they trained were inclined to seek other employment once they had gained the necessary experience and secured their licenses.

A few of the present motorship engineers have served their time and taken out original licenses. The present examination is not so difficult as to discourage any man with good common sense and a reasonable amount of knowledge of his subject.

This is an engineer's problem just as the building of motors is the engine builders' problem and the operation of motorships is the ship operators' problem. For obvious reasons every one concerned must be interested in the other fellow's success, if the development, in its entirety, is to be a success.

Although it seems unfair to the old employees of steamship lines, it appears that the source of supply for future motorships lies in the unemployed, or unsatisfactorily employed, marine steam engineers. This problem creates a cycle which will make the employed engineer of today the unemployed of tomorrow, provided of course motor vessels come to the front rapidly as we have reason to believe they will.

This means labor turnover but not unemployment, with the possible exception of a few of the old timers who will find it difficult to reestablish themselves on the new type of ships. There will always be sufficient steamships to more than care for these and they will do better to remain on them for the new motorships are going to demand young blood.

A number of very disagreeable situations have come up from time to time in connection with placing steam engineers on motor vessels to teach them the new work. They often lose sight of the objective in their zeal for personal advancement and in general make themselves veritable pests. As a matter of fact a number of foolish steam engineers have done much to make it difficult for their fellow engineers to secure employment on motor vessels as oilers or wipers.

Marine superintending engineers have long since learned that it does not pay to interfere with the chief of a ship and his choice of a crew. For this reason it is to be hoped that engineers seeking employment as oilers on motor vessels will forget for the time the fact that they ever were in charge of a watch and will take orders as they would expect orders to be taken.

It is becoming quite common to have steam engineers visit motor vessels to look around. They admit that they have ignored this new development long enough and are now very much interested. Many of them state that they would be willing to sacrifice a certain amount of pay to learn the game but, as the kiddies have to have shoes and the rent must be paid, they can't lose too much. As long as they can stick on their present jobs they hate to take a reduction while learning something new.

The thing which I regret most is the attitude which they take toward their employers. They seem to feel that nothing will be done to give them a chance to learn the new work and stay in the same employment, at a living rate of pay. They feel that the new motorship which their line is to buy will come with engines and engineers, will put their old ship out of commission and them out of employment. This is only their view point and perhaps all wrong, but such things have happened, simply because the employer found it possible to secure experienced motor engineers, who he felt would be more capable of handling the new type of machinery and because there would be no need of disturbing his organization on his steamships.

There is one thing which all engineers can do. Every one can read and post himself on the simple rudiments of oil engine practice. Many are doing it and many others will find it helpful if they do.

If we do our best to profit by past experience, pull together just a little, think of the other fellow once in a while and await developments, not crossing bridges until we reach them, this so-called engineer problem will work out.

Battleship Maryland Awarded Highest Engineering Honors in the Navy

THE red "E," indicating highest engineering honors in the U. S. Navy for the year ending June 30, 1924, has been awarded to the U. S. S. *Maryland*, one of six electric battleships. The award of the previous year went to the U. S. S. *California*. Both of these ships were electrically equipped by the General Electric Company.

The electric propulsion equipment of the *Maryland* includes two 11,000-kilowatt, 2,065 revolutions per minute, ten-stage horizontal Curtis steam turbines, each direct connected to a two-phase alternating-current generator with windings arranged to give 3,000- and 4,242-volt connections for the four two-phase induction motors. These motors are wound so as to give a 24 or 36-pole group of stator windings. The motors are direct connected to the propeller shafts, the thrust of which is taken by a Kingsbury thrust bearing. Six geared

turbine-generator sets supply current for the generator field excitation and power for the ship's auxiliaries. Two motor-driven booster sets are supplied to give a wider range of field excitation on the main generators when maneuvering.

The main operating electrical equipment is placed abaft the engine rooms and between the two outboard motors, thus giving as central a location as possible for the operator.

The M. A. N. Double Acting Diesel

THE development of a two cycle, double acting marine Diesel engine by the Maschinenfabrik Augsburg-Nürnberg, A. G. (the M. A. N.), of Augsburg, Germany, has already been described in considerable detail in our previous issues. In view of the vast amount of practical experience behind this development, including the successful production of a six cylinder, 12,000 horsepower, valve scavenging, two cycle marine engine, the success of the final design, viz.: the port scavenging type, was confidently anticipated.

That these anticipations have been realized is shown by seven months of successful operation of the demonstration engine, diameter 31½ inches, stroke 41¾ inches, which, at 100 revolutions, consistently develops 1,078 brake horsepower on a fuel consumption of 0.41 pound per brake horsepower hour. After having witnessed the tests of this engine and examined the details of the design, many Diesel engineers of wide experience have pronounced it to be a demonstrated success which has definitely passed out of the experimental stage.

While the approval of a new development by competent and disinterested engineers is, of course, excellent evidence of merit, general acceptance of such a development normally awaits the approval of capital as evidenced by the placing of substantial orders. This final proof of success of the M. A. N. development is evidenced by the fact that they have recently booked an order for a 15,000 horsepower engine of this type. It is understood that the construction of this engine will involve nine working cylinders with direct drive of the scavenging air pumps. In this connection, it is interesting to note that the power per cylinder will be slightly more than double that required for cargo ship engines in three and four cylinder units.

With regard to cargo ship engines it is of special interest to note that Messrs. Blohm and Voss, the well-known German shipbuilders, who are also licensees of the M. A. N., have received an order for a three cylinder cargo ship engine of this type, diameter 27.5 inches, stroke 46.25 inches. The New London Ship & Engine Company, a licensee in the United States for the M. A. N. engines, has selected for cargo ship engines in 3 and 4 cylinder units, a diameter of 27.5 inches and a stroke of 43.25 inches. With this cylinder, variations in revolutions from 80 to 100 give a range of shaft horsepower in three and four cylinder units of from approximately 1,800 to 3,000. The longer stroke adopted for the Blohm & Voss order is due to special requirements as to very low revolutions.

Engineers have long recognized that the ultimate engine is the double acting type and, in fact, all of the most important Diesel engine builders in Europe are developing, or have developed, a double acting engine. On account of the Government program for the conversion of Shipping Board steamers which is just about to be inaugurated, the appearance at this time of this type of engine is of special interest to the shipping interests of the United States.

It is of interest to note that both the New London Ship & Engine Company, the pioneer marine Diesel engine builders in this country, and the Hooven, Owens, Rentschler Company of Hamilton, Ohio, hold licenses for the construction of the M. A. N. double acting Diesel engines.

Robert Dollar—Mariner and Trader

How an Aggressive Lumberman Has Won an Outstanding Place in the American Shipping Industry

By V. G. Iden

ABOUT thirty years ago a rather aggressive lumberman operating on the Pacific coast invested in a radical venture. He purchased a vessel of 260 net registered tons and began transporting his own lumber to market. Today this same man owns ships in nearly every important port of the world. He is Robert Dollar, who for individual initiative and ability is a personality seldom approached and rarely equaled in the commercial world. His great adventure in shipping was accomplished after he had passed his half-century mark and today at the age of 80 he is ranked as one of the shrewdest shipping men of the times. Starting from the service initiated by the little coasting steamer *Newsboy*, the Dollar steamship interests now circle the globe.

As a valuation of the man's shipping genius probably no better understanding could be had than that afforded by his life's history. Primarily Captain Dollar is a trader. His first interest is in buying and selling commodities. The operation of ships is but an incident to that activity, as he demonstrates that the success of any steamship enterprise is in the freights offered.

His grey beard shadows a square mouth, otherwise one might observe the line of determination which must play across his countenance almost constantly. The frost-like touch of age has softened considerably what must once have been a grizzled determined man, a hard-working, God-fearing man, a man who has braved the rigors of winters in the lumber camps of Canada and northern Michigan, and who in later years rarely traveled without either his Bible or his wife.

Captain Dollar stares straight, both physically and mentally. His great capacity for work has made it appear as though work with him is a religion, and probably it is such, in a manner of speaking. This is why he has been able to command the best efforts of those who associate themselves with him.

When Captain Dollar went into the transpacific shipping business none of the ships there were flying the American flag. He chartered and he ultimately purchased vessels for this business and those vessels flew the flags of all nations: Norwegian, British, German and Chinese. From this he gained extensive experience in the relative advantages of different flags and finally the transpacific fleet of vessels,

which he ultimately organized, was put under the British flag.

His coastwise fleet was primarily in the Pacific coast trade and was always a dominating factor in that trade. With the opening of the Panama Canal this coastwise fleet was extended to an intercoastal service and after the war the

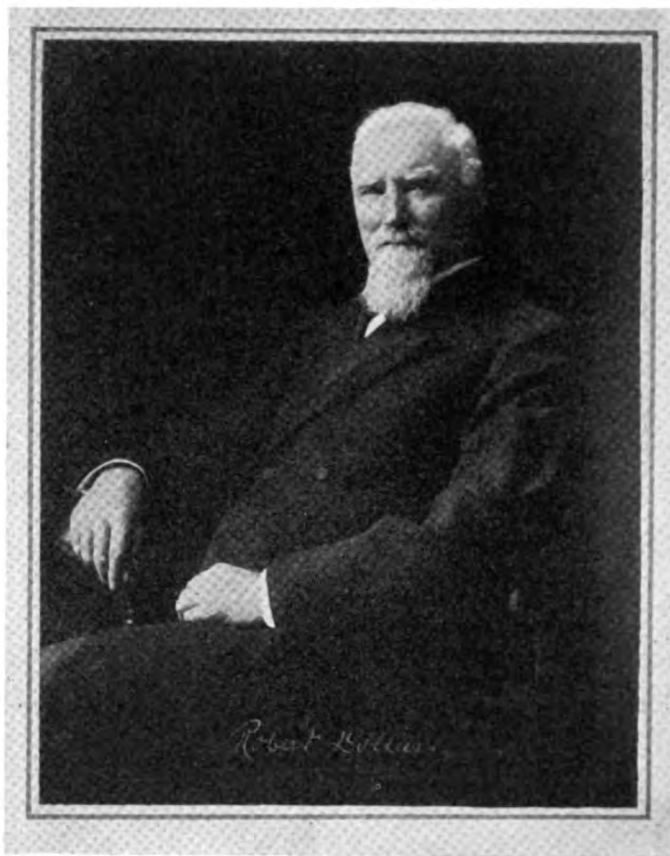
Dollar interests found themselves in control of the Admiral Line which operates passenger ships between Seattle and San Diego.

With the outbreak of the war and the enactment of an enabling act Captain Dollar brought his British ships under the American flag anticipating that the day would come when the United States would revise its statutes in order to give American shipping an equal chance with foreign flag ships. But with the La Follette law on the statute books, American owners refused to transfer more of their ships from foreign register. Captain Dollar, however, never returned one of his ships to a foreign register once it had been put under the American flag and after the war he actually purchased some foreign flag tonnage and transferred it to American register. These facts are cited to show that he had undeniably cast off his foreign inheritance and sealed his business future under the Stars and Stripes.

Robert Dollar was born at Falkirk, Scotland, in 1844. His uncle and grandfather were seafaring men, whereas his father was in the lumber business in Scotland. He migrated to Canada in 1858 and started work in a stove factory in New Edinburgh at a monthly wage of \$6. He finally went to the lumber camps and ultimately became an operator in lumber. His first venture threw him into bankruptcy, but he went back to work at a wage and paid off all his obligations and made a second start. He developed a lumber business with his home country, starting his operations in Canada and gradually spreading over into Michigan.

As his lumber business grew Captain Dollar gradually divorced himself from the production side and began traveling around looking after his markets. It was not long before he found himself traveling so much in the interests of business that he measured the distance traversed in one year as equal to twice around the world. He moved to California in 1888, establishing his business headquarters in San Francisco.

In 1893 Captain Dollar started a mill at Usal, California,



Captain Robert Dollar

and ran it for six years. It was during that time that he initiated his investments in ships. He found transportation charges excessive and endeavored to obtain ships and transport his own lumber to market. He first purchased the *Newsboy*, of some 300 tons. She paid for herself in less than a year. In 1901 he made his first venture in the China trade with the steamer *Arab*, capacity 6,500 tons. That trip did not pay because the vessel carried only a half cargo. Captain Dollar also acquired interest in a lumber mill near Everett, Washington, in order that he might supply cargoes for his ships. He sent the first steamer of his own ownership, the *M. A. Dollar*, to China about this time. The trip showed a loss wherefore he decided that if he was to make a success of shipping he must have his own organization in the field. That thought prompted him to make his first trip to the Orient in 1902.

This was the beginning of numerous trips to the Orient, which carried him across the Pacific once and sometimes twice a year for the next few years. One result of his first trip was the working up of trade between Kakodate, Otaru, Muroran and the United States. He cut Japanese oak in that territory and brought samples of it back to the States, which he had made into furniture. He then sold the Japanese oak in the form of ties to the Southern Pacific Company, which had started extensive railroad building in Mexico. In this manner he was able to ship Oregon fir ties from Puget Sound to Tientsin, China, and returning, loaded oak ties in Japan for Mexico. After this he bought oak logs in Mexico and sold them in San Francisco and Los Angeles. This proved to be a freak of commerce, but it developed into quite a business and upon the transactions Robert Dollar was able to reap profits and at the same time provide his own ships with profitable cargoes.

THE TRADER IN ACTION

In the Orient he began by developing a lumber business, establishing yards, terminals and even investing in such standing timber as the Orient possessed. But he did not stop with lumber alone, but personally visited Japan, China, Java, the Philippines and Australia. In Java he started by bringing sugar cargoes to the United States. Later on this was to be developed further by transporting rubber, not only to the United States, but to Europe, in competition with the established British lines. It was this which started him in the westward trend of commerce around the world and which has finally developed into the combination passenger and freight service circumnavigating the globe.

The panic of 1907 tied up his whole coastwise fleet and stagnated his purely domestic business, but it enabled him to give more attention to his Oriental trade. During the interim he strengthened his organization throughout the Orient and set out to develop more trade with that part of the world. Conditions existing until then in the Philippines had deterred him from making connections there, but in 1908 he made another investigation.

THE PHILIPPINE TRADE

"The change impressed me so favorably," recounts Captain Dollar, "that I decided to look into the Philippine trade, but Mr. Taft practically told me, on his arrival to be governor, that American shipowners were not wanted. He had the foolish idea that the poor Filipinos would be able to furnish all the ships they wanted although they neither had the experience, money nor get-up. All this has been fully demonstrated of late years. Where we are not wanted is a good place to keep away from, which I did from the Philippines for seven years, but then we went back and started doing a very satisfactory business."

Commenting later upon his venture into the Philippines, he said:

"We sent cargoes to the Philippines some years ago, and

in order to make the voyage profitable brought copra back with us. Previous to that no trade in copra with the Philippines existed. Now it is very satisfactory, amounting to from 20,000 to 30,000 tons a year. We are now developing Philippine mahogany along exactly the same lines we developed Japanese oak, bringing 4,000,000 feet a year in our own ships. It does not yield a profit yet, but later on it will. Our ships which bring it are trade missionaries.

FOREIGN TRADE HIS GOAL

In 1910 he made an attempt to start the iron trade of China and was instrumental in having the Western Steel Corporation establish a plant in the Orient. The company, however, became involved in financial difficulties a few years later and had to withdraw and the Japanese took its place. This was a worthy effort, despite its failure, as it was calculated that the pig iron produced from China ores would find a ready and active market on the Pacific coast, and naturally Dollar ships were ready to transport it.

"My interests are more in foreign trade than shipping," he once told a public gathering, "though you are led to believe that my interests are more in shipping."

In 1917, because of the hostile La Follette law Captain Dollar transferred his operations to Vancouver, where he began building a shipping terminal, a saw mill, a lumber camp and the township of Dollarville. From this point on he gave considerable attention to buying up terminal properties and building up a good commercial organization to develop cargoes for his ships. The opening of the Panama Canal brought him into New York and here he has only recently acquired title to land and begun the construction of an adequate freight terminal.

A BUSINESS MISSIONARY TO THE ORIENT

An accomplishment such as his would have been impossible without drawing the man into public prominence. In an international way this was manifested first about 1908 when Captain Dollar headed a delegation from the Associated Chambers of Commerce of the Pacific Coast to visit Japan. Due to the intensive way in which he had cultivated the Oriental peoples and his great knowledge of their customs and commerce, he was called upon to make addresses and otherwise act as the spokesman for the visiting Americans. This same kind of a trip was repeated in 1910 when the American commercial representatives paid an official visit to China at the invitation of the various chambers of commerce of China. And in 1915 when the Chinese returned the visit Captain Dollar voyaged across the Pacific so that he could accompany the delegation personally from China through the United States.

In 1911 he was sent to the Orient to extend official invitations to the Japanese, Chinese and Filipinos to join in the Panama Pacific Exposition in San Francisco. He fulfilled that mission successfully despite the fact that when he reached China that country was in the throes of a revolution. As showing the veneration in which the Chinese people held him Captain Dollar was able to pass through the lines of the warring factions and to hold converse freely with Chinese leaders on both sides. Furthermore, the Chinese remembered that he had been unstinting in his benefactions. They had not only received from him building materials for their temples but he had made many other gifts both public and private.

These semi-public activities drew him into commercial prominence and therefore it is not surprising to find that Captain Dollar has been eagerly sought after to serve on the boards of allied corporations and lend his support to sundry contributory movements.

In dealing with governments officially, Captain Dollar possesses a record for prudence and luck. In 1904 his ship, the *M. S. Dollar*, was chartered to the Russian government



Route of the Dollar Round-the-World Passenger and Freight Service

and captured by the Japanese while she was attempting to run a blockade. This ship was insured for \$180,000, so he lost nothing thereby. The Japanese used her as a transport and then put her up at auction in 1906 whereupon Captain Dollar bid her in for \$55,000.

CAPTAIN DOLLAR'S PART IN THE WORLD WAR

When the European war broke out he was appointed a member of the committee of experts who drafted recommendations which resulted in our emergency shipping laws. Then he devoted his best energies to reap some of the profits which came to all shipping by reason of the war. He purchased new vessels and sold his old ships, in each instance making profits on the deals.

"Secretary Bryan once told me," said Captain Dollar, "to stay at home with my ships or I'd get into trouble. I said, I won't."

He had eight freighters built on the Clyde for his Vancouver-Orient services and started actively into the business. But in 1917 the British Admiralty commandeered the three steamers he had in that service under the British flag. He proceeded to Hong-Kong and there worked out a contract with the British which proved very profitable to himself. He carried coolies to Vancouver and carried war supplies back to Vladivostok. The extra space on his ships he was allowed to use for his own goods.

It was also in 1917 that Captain Dollar negotiated a contract with the U. S. Shipping Board to build eight cargo ships for them in the Chinese Government navy yard at Kiangnan. The contract was for \$14,000,000 (subsequently reduced), and was concluded through Wellington Koo, the Chinese Ambassador at Washington. For his part in the

negotiations the Chinese Government decorated Captain Dollar with the order of the Chia Ho.

With the close of the war Captain Dollar was signally prudent in that he did not rush in to buy government tonnage at the prices first offered. Ultimately he acquired some excellent ships built for the Shipping Board but the prices he paid were more in line with the present market value of the vessels.

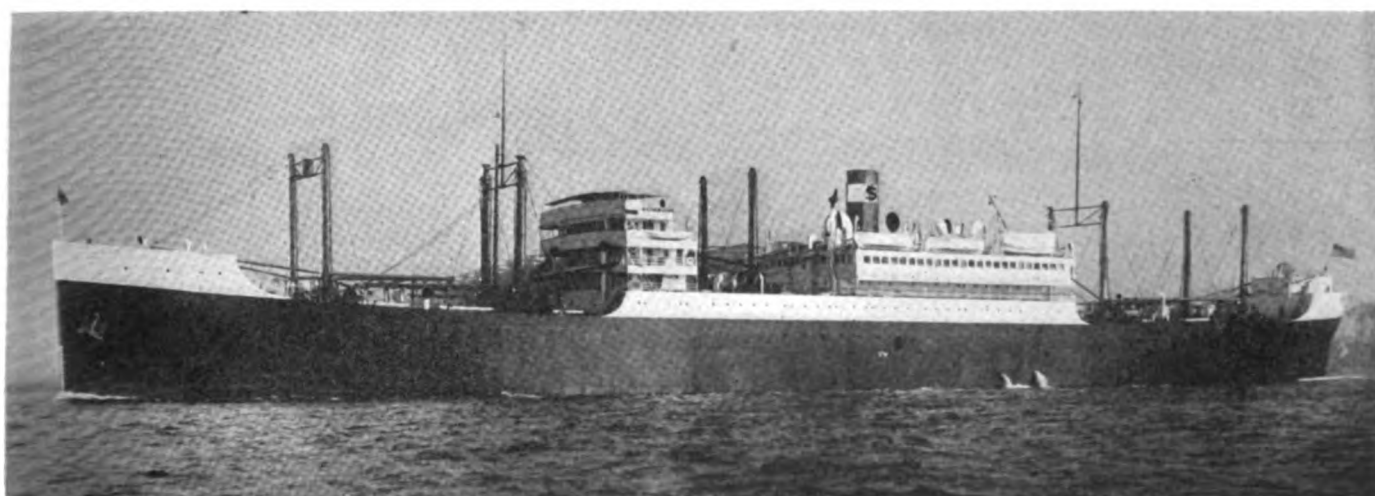
A LIBERAL BENEFACTOR

But let it not be thought that Captain Dollar was forever chasing the monetary profits. Scotchman that he is, he has displayed much sentiment in his life. He has made several substantial gifts to his birthplace, Falkirk, Scotland. He built a Y. W. C. A. building in China in memory of his daughter-in-law, endowed several Oriental undertakings of the Y. M. C. A., and he has endowed chairs at the San Francisco Theological Seminary. Moreover he has made substantial gifts to his church in San Rafael, and contributed to California charities which deal with the Orientals in our midst.

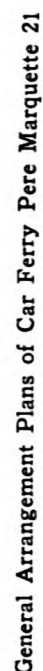
As he wrote once in his diary:

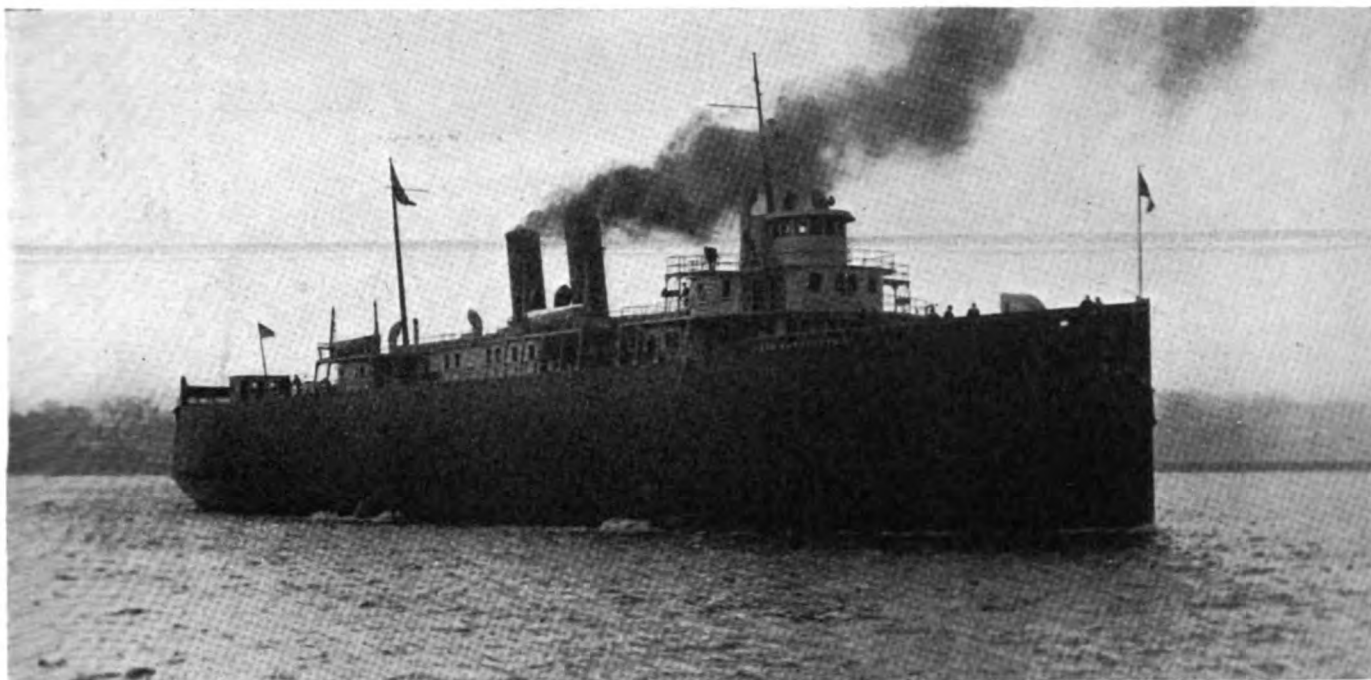
"Thankful to close the year after having had a successful business year and having earned money to spare, so that I was enabled to spend a considerable sum for those in need, and also to aid in the evangelization of our own country as well as of China and Japan. During this year our business has grown and expanded beyond expectations. This is especially true of our trade in China, for which we give thanks to Almighty God for it all, as without His help it never could have come about."

And that with but slight change could serve as his epitaph.



One of the "President" Ships That Captain Dollar Bought from the Shipping Board for His Round-the-World Service





New Pere Marquette Car Ferry Built by Manitowoc Shipbuilding Corporation for Service on Lake Michigan

Car Ferry Pere Marquette 21 Commissioned

Twenty-six Thousand Ton Vessel Built for Service on Lake Michigan by Manitowoc Shipbuilding Corporation

THE car ferry *Pere Marquette 21*, built by the Manitowoc Shipbuilding Corporation, Manitowoc, Wis., to the order of the Pere Marquette Railroad, has recently been put in service on Lake Michigan.

This vessel has an overall length of 360 feet; length between perpendiculars, 348 feet; molded breadth, 56 feet; molded depth, 21 feet 6 inches; draft, loaded, 16 feet; dead-weight capacity 2,600 tons; gross registered tonnage, 2,992; speed, loaded, 14 miles. She is built on the system of transverse framing and classed A-1 by the American Bureau of Shipping.

PROPELLING MACHINERY

The *Pere Marquette 21* is powered with two triple expansion engines with cylinders 20½ inches, 34 inches and 56 inches diameter by 36 inches stroke with an indicated horsepower of 1,350 each.

Steam is supplied by 4 Scotch marine boilers, working at a pressure of 185 pounds per square inch, having a length over heads of 11 feet and a diameter of 14 feet 6 inches. Each boiler is fitted with three 42-inch Morison type furnaces. The Howden forced draft system is used.

The auxiliary machinery includes:

Two 14 by 28 by 18-inch air pumps and jet condensers.

One 50 - gallon Jewell-Pola distiller.

One No. 18 Reilly feedwater heater.

Two 10-inch by 6-inch by 12-inch main feed pumps.
One 10-inch by 5-inch by 12-inch ashgun pump.
One 8-inch by 5-inch by 12-inch general service pump.
One 8-inch by 5-inch by 12-inch sanitary pump.
One 8-inch centrifugal ballast pump.
One 8-inch by 10-inch by 12-inch bilge pump.
One 6-inch by 4-inch by 6-inch cooler pump.
One 4-inch by 2½-inch by 5-inch fresh water and distiller circulating pump.
One 4-inch by 2½-inch by 5-inch refrigerator pump.
One 3½-inch by 2¼-inch by 4-inch water pump.

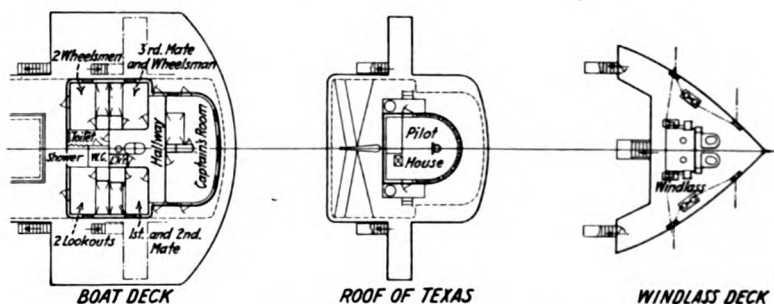
The vessel is also equipped with a one-ton Brunswick-Kroeschell refrigerating plant; the electrical equipment includes two 15-kilowatt Engberg generators.

The personnel consists of a crew of 46 officers and men, and facilities are provided for accommodating 24 passengers.

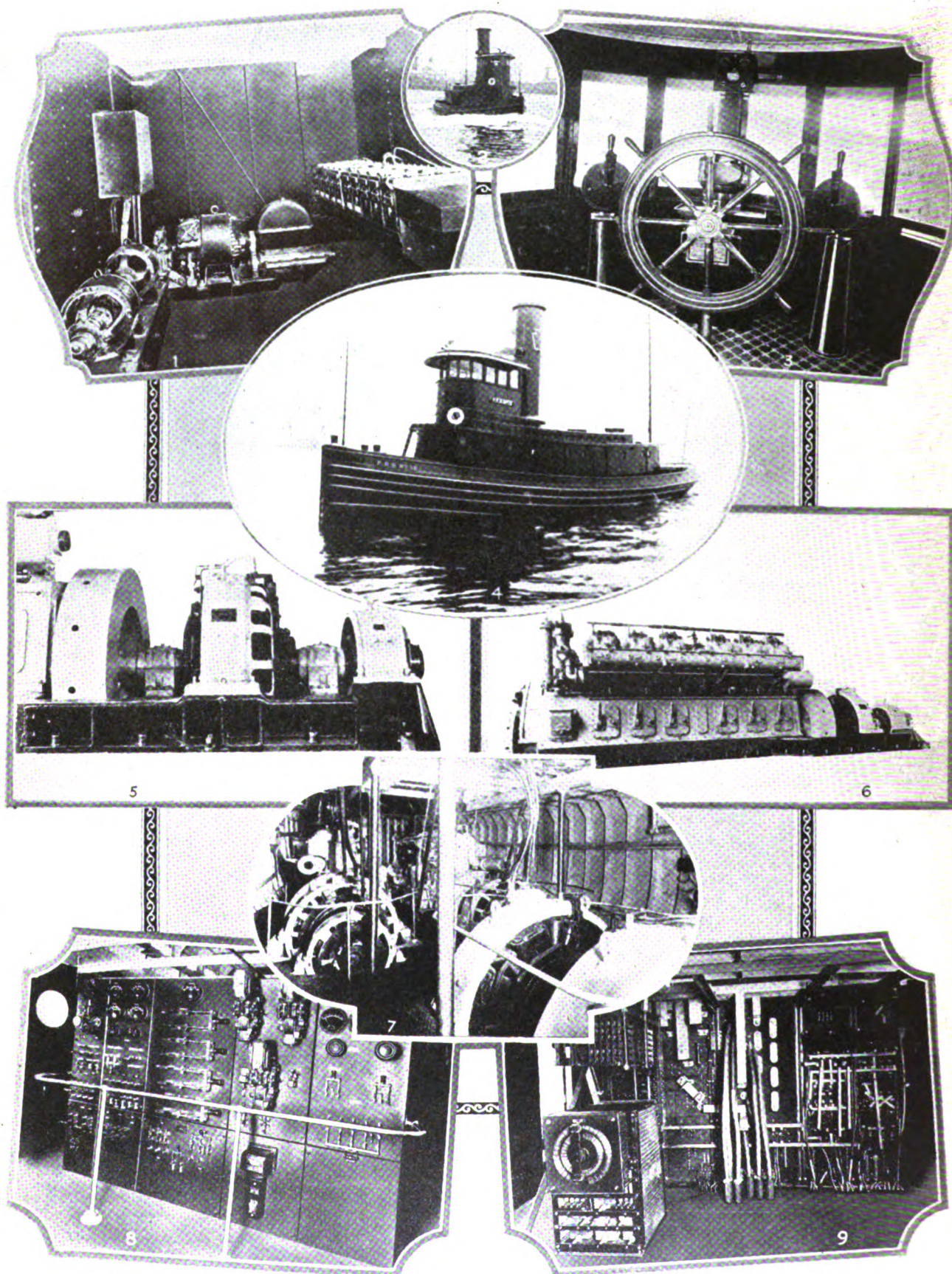
The propellers are of the sectional type 12 feet in diameter with a pitch of 14 feet 6 inches.

The life saving equipment comprises four 22-foot lifeboats and one 30-person life raft.

The steering gear consists of a 9-inch by 9-inch main steerer and an 8-inch by 8-inch auxiliary steerer. The deck machinery also includes an 8-inch by 8-inch spur geared windlass, a hand capstan, a mooring engine and four car deck capstans. There are two anchors, each of 4,340 pounds.



S. S. Pere Marquette 21: Partial Deck Plans



Diesel Electric Tug P. R. R. No. 16: (1) Steering Motor and (Left) Motor Generator for Charging Batteries, (2) Full Speed Maneuvering Test, (3) Pilot House Control, (4) General View of Tug, (5) 235-Kilowatt Generator, (6) Main Diesel Generator Set (7) Engine Room, (8) Main Switchboard, Looking Aft, (9) Main Switchboard, Looking Forward

The First Diesel Electric Tug

Superiority of Diesel Electric Drive for Towboats Demonstrated in New Vessel Built for Pennsylvania Railroad

WHAT may well prove to be an epoch making vessel was given a series of exhibition runs on North river, on August 20. The *P. R. R. No. 16*, the first tug to be fitted with Diesel electric propelling machinery, has been in service in New York harbor for about a month, and on the date mentioned a large number of government officials, engineers, shipping men and towboat operators were given an opportunity, by Mr. F. L. DuBosque, superintendent of floating equipment of the Pennsylvania Railroad, to inspect the new boat in operation.

The vessel is a duplicate, except as regards propelling machinery, of other tugs owned by the railroad company and, for this reason, its performance is of much more than ordinary interest.

ADVANTAGES OF DIESEL ELECTRIC DRIVE FOR A TOWBOAT

While there is great difference of opinion as to the advantages of Diesel-electric drive for cargo vessels and other ships of constant speed, the peculiar suitability of this type of propelling machinery for a towboat was amply demonstrated on the exhibition runs. The most noticeable point of superiority over a steam tug is the ease and rapidity with which the vessel can be maneuvered, a feature of paramount importance in towboat service. From full speed ahead (about 13 miles an hour) the boat was stopped dead and commenced to move astern in 30 seconds, a feat quite impossible with any form of direct steam propulsion. In fact, the reversing of the motors, which are controlled from the pilot house, is accomplished so quickly as to throw one off his balance if standing at ease.

FULL BACKING POWER IMMEDIATELY AVAILABLE

The sudden reversing causes an overload of about 50 per cent on the engines, but the energy stored up in their rapidly revolving flywheels is quite sufficient to carry them by the peak of the load and the variation in revolutions is very slight. In consequence, full backing power is exerted practically at once. For the same reason, full power is exerted when the helm is put hard over, the engines being maintained at constant speed by the flywheels and governors, and as a result, the boat turns very rapidly, a complete circle, made at full speed, having an apparent diameter of about twice the length of the boat.

A towing trial between the Diesel electric and a steam tug of the same model and dimensions, resulted greatly to the advantage of the former, it being found that, with identical tows, the more uniform power developed by the Diesel-electric machinery, resulted in considerably greater speed of towing.

Several of the guests on the trials were emphatic in their assertions that the *P. R. R. No. 16* was the quickest and easiest handling towboat that they had seen.

FUEL COST LOW

It was stated that the fuel cost per day, on ordinary service, using Diesel oil, is somewhat less than one-half the cost of ordinary fuel oil for an oil burning steam tug of the same power; also that when lying at the pier "cold," the tug could be got underway, at full power, in about 2 minutes.

The owners of the tug, as a result of their month's experience with her, stated that, in their opinion, her economical and superior performance would easily result in the vessel's

paying for the additional cost of the machinery, in a year's time.

DETAILS OF THE TUG

The *P. R. R. No. 16* is 105 feet long, 24 feet beam and draws 12 feet of water. The load displacement is 340 tons. The hull, waist, fenders and houses are of steel throughout.

Motive power is furnished by two Winton, full Diesel engines, each having six cylinders, $13\frac{1}{4}$ inches in diameter and 18 inches stroke. The rotation is constant, in one direction, and automatically controlled. The engines are started by air, and one engine can be started electrically if the other is in operation. Each engine drives a Westinghouse direct current, shunt wound generator, rated at 235 kilowatts at 250 volts, and has attached to it a 25-kilowatt compound wound exciter. In addition to excitation, the exciters furnish current for all the auxiliaries on the boat.

The propelling motor is of the shunt wound, double armature type, rated at 575 horsepower at 500 volts and 125 revolutions per minute. The propeller is of cast iron, 9 feet 6 inches in diameter and 9 feet 4 inches pitch.

The rudder is controlled by a motor driven steering engine of the simple hoisting type, the pilot house control being of the non-follow up system.

Light is furnished by storage batteries, automatically charged by a motor generator. The boat is heated by passing air around the muffler attached to the exhaust pipes of the main engine, and then through ducts to the location desired. An electric fan is used to circulate the air.

The whistle is operated by air taken from the second stage air compressor on the main engines.

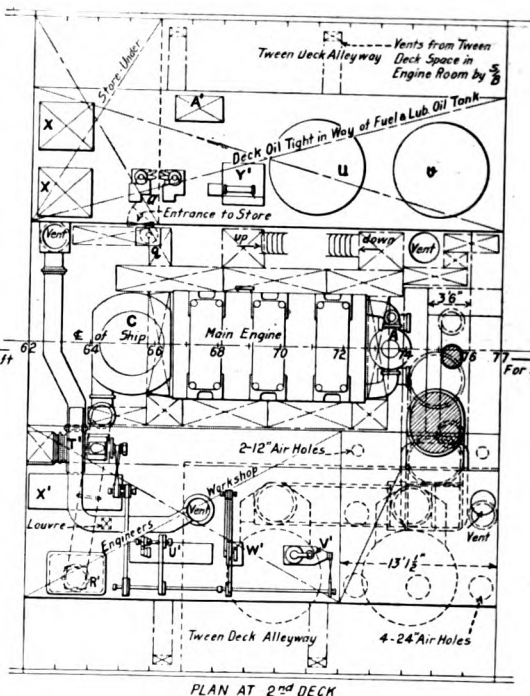
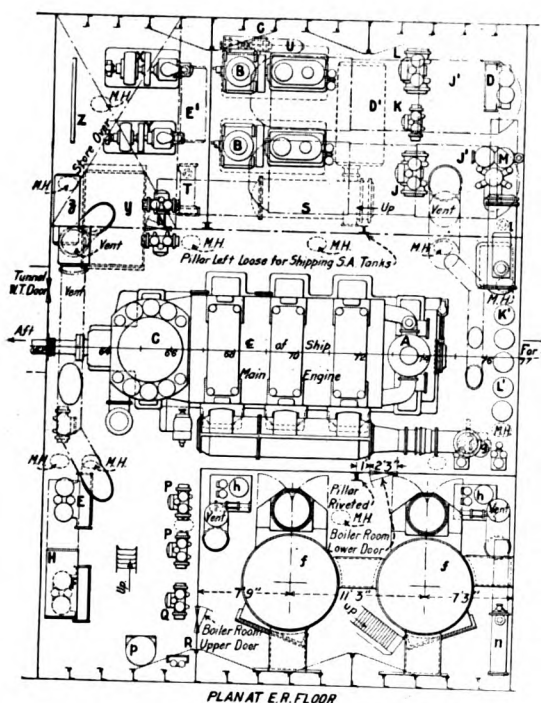
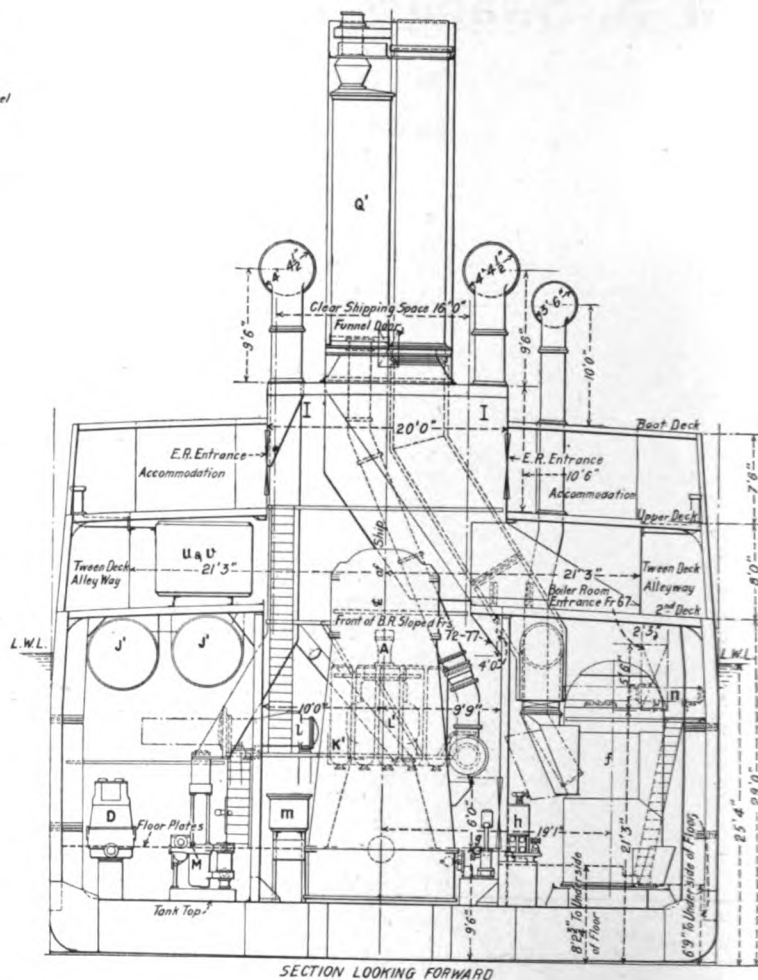
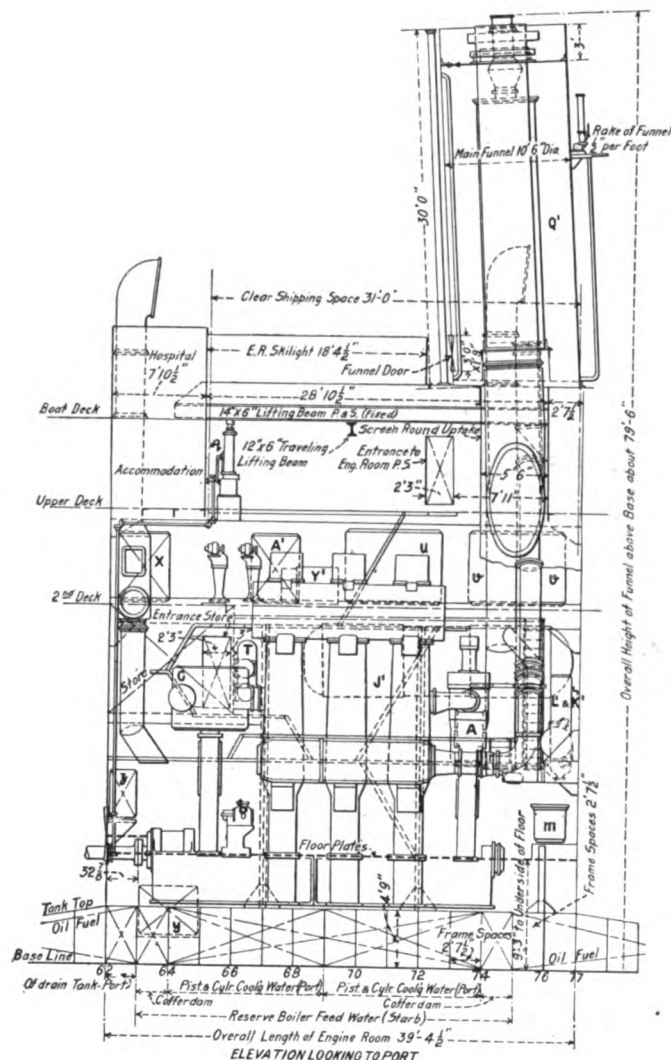
POWER AND SPEED DEVELOPED

The rotative speed of the motor is controlled on the Ward-Leonard system of variable generated voltage, so that any speed from zero to the maximum can be instantly obtained by the appropriate movement of a lever on a control stand. The maximum speed the boat attained was 13.52 statute miles per hour, when 646 horsepower was delivered to the propeller shaft, and revolutions of propeller 133 per minute. When towing, a speed of 6.36 miles per hour was attained with a stress on the towing hawser of 15,180 pounds, at which time 629 horsepower was delivered to the propeller shaft, and revolutions of propeller 117 per minute.

The work this type of tug performs is such that she can operate a large part of the time on one generating unit. Under this condition the light speed is 11.25 miles per hour and the towing speed 5.10 miles per hour, with hawser stress of 9,500 pounds and 328 propeller horsepower.

The rotation of the propeller wheel is controlled directly by the pilot. Two control stands similar to annunciators are fitted on either side in the forward end of the pilot house, and the levers act in unison.

The hull of *P. R. R. No. 16* was built by the Staten Island Shipbuilding Company, of New York, the engines by the Winton Engine Company, Pittsburgh, Pa., and the generators, motors and other electrical equipment, by the Westinghouse Electric & Manufacturing Co. of Pittsburgh, Pa. These parts were assembled and installed and the boat was fitted out at the Hoboken Shops of the Pennsylvania System, completed on July 8, and placed in the service of towing barges and floats in New York harbor on July 14, 1924.



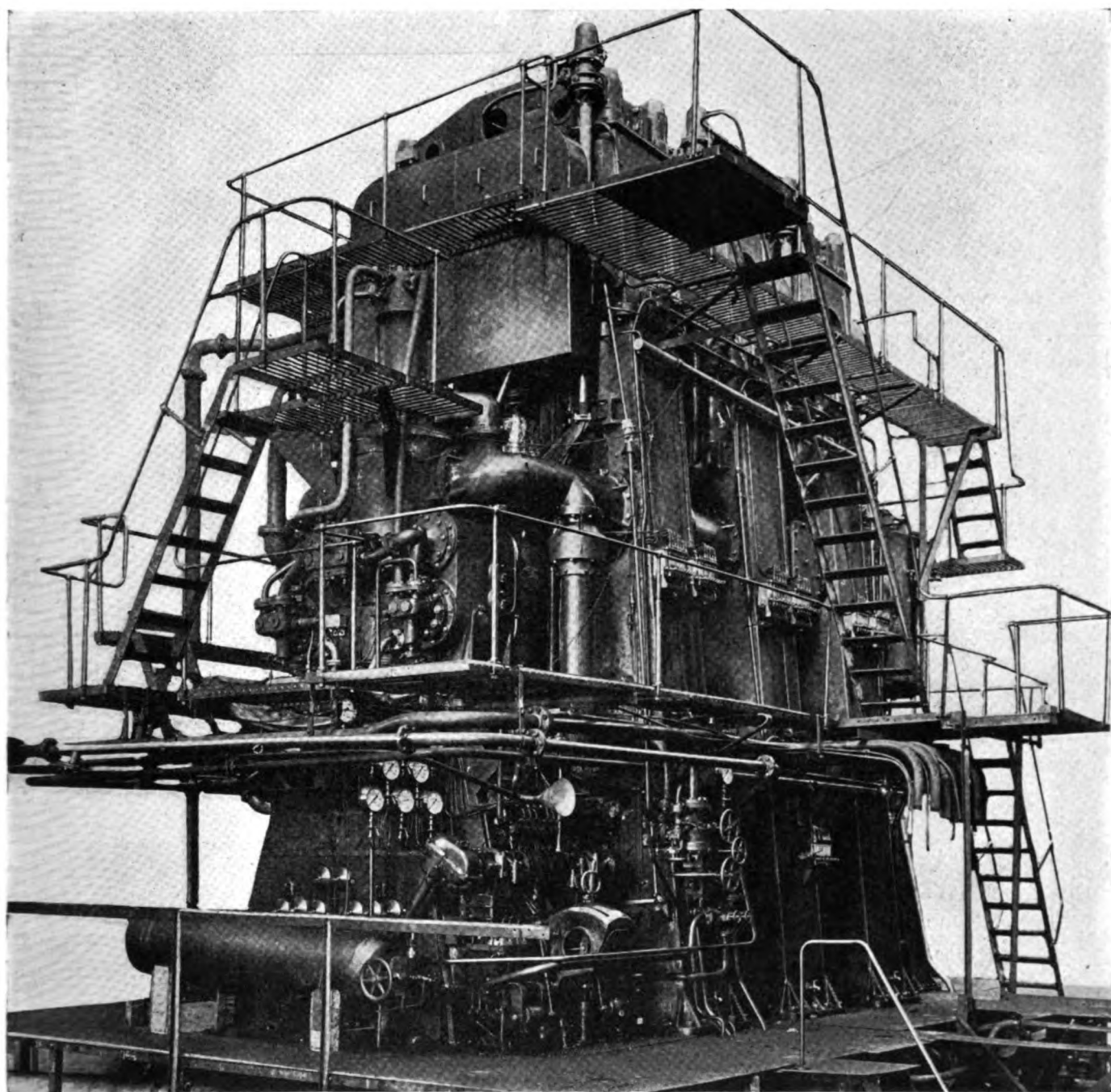
M. S. Swanley: Machinery Arrangement

- A, main air compressor.
- B, auxiliary air compressors.
- C, scavenge pump.
- D, ballast pump.
- E and F, fuel transfer pumps.
- G, oil fuel pump.
- H, oil fuel heaters.
- J, cylinder cooling pump.
- K, piston cooling pump.
- L, cooling standby pump.
- M, air pump.
- N, lubricating oil pumps.
- P, bilge pumps.
- Q, sanitary pump.
- R, fresh water pump.
- S, cooling water cooler.
- T, lubricating oil coolers.
- U, fuel heater for separator plant.
- X and Y, generator sets.
- Z, switchboard.
- a, fuel oil separators.
- b, turning gear motor.
- c, separator supply pump.
- f, boilers.
- g, feed pumps.
- h, oil firing plants.
- i, condenser.
- m, feed filter tank.
- n, surface feed heater.
- p, evaporator.
- q, distiller.
- u and v, daily service tanks.
- x, lubricating settling tanks.
- y, lubricating drain tank.
- z, lubricating reserve tank.
- A', cylinder lubricating oil tank.
- B', paraffin oil tank.
- C, Colza oil tank.
- D', cooling water-drain tank.
- E, purified fuel oil tank.
- J, starting air storage tanks.
- K, air bottle.
- L, reserve air bottles.
- Q, silencer-exhaust.
- R, silencer-scavenge inlet.
- T, fan and engine.
- U, lathe.
- V, drilling machine.
- W, grinder.
- X', vice bench.

M. S. Swanley Equipped With North British Engine

First British-Built Ship to Be Equipped with Double-Acting
Two-Cycle Engine—A Remarkable Saving in Space

By Our Special London Correspondent



The 2,000 Brake Horsepower Double Acting Two Cycle Engine Installed on the Swanley

IT is an interesting development that within a few days of the publication of the report of the Advisory Committee appointed by the Shipping Board to deal with the question of the types of engine for the conversion of steamers, in which it recommends that the development of the double-acting engine should be encouraged, the first British ship to be equipped with machinery of this class sailed on her maiden voyage. There is actually, at the present moment, no

other vessel afloat in which double-acting motors are installed. The *Fritz*, a small cargo craft built before the war, was engined with a double-acting two-cycle plant, but the design was not particularly satisfactory and is quite out of date; moreover, the engines have since been removed. Thus, it may almost be said that the completion of the *Swanley*, as the new ship is named, represents something of a new era in marine propulsion.

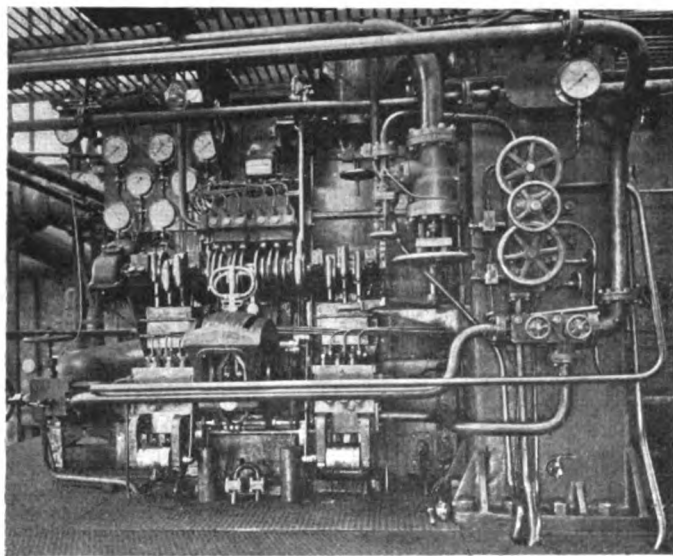
She has been constructed by Messrs. Barclay, Curle and Company, Ltd., for Messrs. Harris and Dixon of London, a firm which is associated with Messrs. Furness, Withy and Company, who have lately added a number of motorships to their fleet. Incidentally, this same firm has combined with three well-known engine builders (Richardsons Westgarth & Company, Beardmore and Tosi), to develop further types of double-acting machinery, and this indicates how active an interest British shipowners are showing in the possibilities of the new system.

PRINCIPAL DIMENSIONS

The main dimensions and particulars of the *Swanley* are as follows:

Length	410 feet
Beam	55 feet 3 inches
Depth	29 feet
Draft	25 feet 7 inches
Deadweight capacity	9,330 tons
Brake horsepower	1,850
Speed	10 knots

The engine installed is the remarkable sliding cylinder design as originated by the North British Diesel Engine Works on the Clyde. A description of this motor has already



Controls of the *Swanley's* Engine

been published in MARINE ENGINEERING AND SHIPPING AGE and it will only be necessary to recall the main details. It has three cylinders, 24½ inches diameter and 44 inches stroke, and the speed is 100 revolutions per minute. The length of this engine is about equivalent to that of a reciprocating steam engine of equal power, so that the whole of the space needed in a steamer for the boiler and bunkers is thrown open to cargo in the new vessel. In this way, there has been an increase in the space capacity of the ship to the extent of 41,000 cubic feet as compared with that available in a steamer. It may be added that the weight of the engine is about 230 tons and although this could be reduced (and will be in the next engines) it represents a saving of about 130 tons, as compared with the weight of a corresponding four cycle single acting engine.

The upper and lower cylinder covers are fixed and the cylinder slides over them, the travel being about 13 inches. The object of this movement is to enable the scavenging air to enter the cylinder through the ports in them, when they are uncovered during the movement of the cylinder over the cylinder covers. The exhaust ports are arranged in the center of the engine, and the exhaust gases are discharged through them when they are uncovered by the piston. One obvious

advantage is that all necessity for scavenging valves is eliminated, while the scavenging air sweeps right through the cylinder, thus giving an excellent scavenging effect and improving combustion. Moreover, there is no piston rod passing through the bottom cylinder cover so that the location of the fuel valve is a matter of simplicity. The gudgeon pin is extended each side and passes through slots in the cylinder walls, the drive on to the crankshaft being taken through rods and the forked connecting rod. Further details of this engine can be obtained from the article previously referred to. In the works, a fuel consumption of 0.45 pound per brake horsepower hour was obtained, which is somewhat high, but it is hoped that this will be improved in due course.

THE AUXILIARIES ARE STEAM DRIVEN

All the auxiliary machinery in the ship is steam-driven, which detracts from the general economy, since 1½ tons are required for the boiler, while the propelling engine needs only about 6½ tons daily for a speed of 10 knots. Steam auxiliaries are, however, much cheaper than the electric type, and many British shipowners prefer them for this reason.

Two oil-fired Cochran boilers are fitted in the engine room, working at a pressure of 100 pounds per square inch. Only one of these, of course, is needed for operation when the ship is at sea.

The piston cooling system is of some interest, since not only is fresh water utilized, but it is distilled. One of the advantages of fresh water is that as it circulates around a closed circuit, the inlet temperature to the pistons and cylinders can be controlled, and kept moderately high, which is better than allowing cold sea water to enter.

A good many shipowners now consider it desirable to purify the fuel oil used on Diesel ships, even though they utilize Diesel oil and not boiler oil. Hence, two Sharples centrifugal separators are installed in the engine room, one of which is employed for purifying the lubricating oil, the other for the fuel. It is probable, however, that after the ship has been in service some time, she will be operated on boiler oil, in which case the centrifugal separator becomes not only desirable but absolutely necessary.

There are two auxiliary steam driven compressors of the three stage type, running at 320 revolutions per minute and two steam driven dynamos, one of 12½ kilowatts and the other of 20 kilowatts. The winches on deck are also steam driven and of these there are 11. The windlass and steering gear are likewise driven by steam.

During the trials, which included a three days' run, the engine behaved perfectly, and although many people considered that much vibration would be felt, this was particularly absent. On the completion of the trials, the *Swanley* loaded coal and proceeded on her maiden voyage to the East, which will last five months.

OTHER INSTALLATIONS BEING MADE

The owners have placed an order for a second ship similar in all respects, and there are two other vessels under construction in which North British double acting engines will be fitted. In one of these, a motor similar to that on the *Swanley* will be installed, while in the other there will be a four cylinder set developing about 2,700 brake horsepower, but with cylinder dimensions the same as those in the previous engine. It will thus be gathered that already a considerable degree of confidence is felt in the design, in spite of its revolutionary characteristics and its future will therefore be watched with the greatest interest.

As previously mentioned, the space is about equivalent to that of a reciprocating steam engine, so that the type appears to be particularly well adapted for the conversion of steamships, provided, of course, its reliability can be absolutely guaranteed.

New Great Lakes Steamer Greater Detroit Goes Into Service

THE new side-wheel combination steamer *Greater Detroit* recently completed by the American Shipbuilding Company, Cleveland, O., for the Detroit & Cleveland Navigation Company, Detroit, Mich., was placed in commission on the route between Detroit and Buffalo on August 26. The *Greater Detroit* is the largest and speediest passenger steamer ever built on the Great Lakes and cost \$3,500,000. Her sister ship, the *Greater Buffalo*, which was launched about the same time by the Great Lakes Engineering Works, Detroit, Mich., will be placed in commission on the Detroit and Buffalo run as soon as she is completed. The vessels were designed by Frank E. Kirby, the veteran naval architect, of Detroit and New York.

For the particular service of the *Greater Detroit* and *Greater Buffalo*, the draft is limited to about 16 feet and the maximum breadth to 100 feet over the guards. The route these vessels are to follow traverses the length of Lake Erie with shallow channels at both ends, a distance of about 260 miles, which must be made on a schedule close enough to meet the departure and arrival of certain trains. This condition requires speed while the difficulties of navigation in the narrow channels at both ends of the route necessitate a comparatively light draft and exceptional facility in maneuvering. The shortness of the operating season, which is usually less than six months, puts a premium on reliability of the power plant. All these general considerations have necessitated the building of vessels which are of exceptional length, speed and passenger carrying capacity, coupled with proportionate strength and maximum safety.

The *Greater Detroit* has a length over all of 550 feet, a breadth of hull of 58 feet, a breadth of hull over guards of 100 feet and a molded depth of 23 feet 6 inches. The designed speed is 22 miles per hour and on her trial trips the new vessel exceeded her contract speed.

Some idea of the extent of the accommodations may be gained from the following list of passenger rooms:

Promenade deck: Rooms with two berths, 105; rooms with one berth, 32; rooms with two berths and toilet, 50;

rooms with two berths, toilet and shower, 4; parlors with bath room, 12; parlors with toilet and shower, 2; total rooms, 205.

Gallery deck: Rooms with two berths, 138; rooms with one berth, 24; rooms with two berths and toilet, 76; rooms with two berths, toilet and shower, 4; parlors with bath rooms, 12; total rooms, 254.

Upper deck: Rooms with two berths, 166; total rooms, 166.

The crew comprises over 300 officers and men.

In addition to these major features the demands of freight and automobile shippers require the allocation of most of the space between the main and promenade decks for their use.

The *Greater Detroit* has a rudder at each end, the bow rudder being necessary to facilitate handling in the narrow

waters at each end of the run. The stern rudder, which is of the balanced type, is operated by twin independent steering engines acting direct on the quadrant. The bow rudder is controlled by a single direct acting steering gear. These steering gears are controlled from the pilot house through shafting and gearing.

The hull is of steel and is subdivided into 11 watertight compartments by steel watertight bulkheads extending from the keel to the main deck. The double bottom is subdivided into 16 watertight compartments.

Accommodations for the deck, engineers' and stewards' departments are on a steel orlop deck both forward and aft of the machinery which is well forward of amidships. The freight space is on the main deck forward and the lobby entrance, cafeteria and dining room are aft with galley and pantry and other necessary rooms on the orlop deck. Passenger accommodations are located on the promenade, gallery and upper decks.

The requirements as to drinking water are very strict and necessitate piping distilled water all over the ship. Water is carried in steel tanks of about 36,000 gallons capacity, and there are tanks of 8,000 gallons capacity for sterilized water, which after being chilled, is pumped to drinking fountains throughout the vessel.

As the greater part of the operating season of the vessel is during the heat of summer the ventilating problem has received very careful attention. Sheet metal ducts lead fresh

(Continued on page 530)



Main Saloon



Sketch of the Greater Detroit



Corner of Dining Room

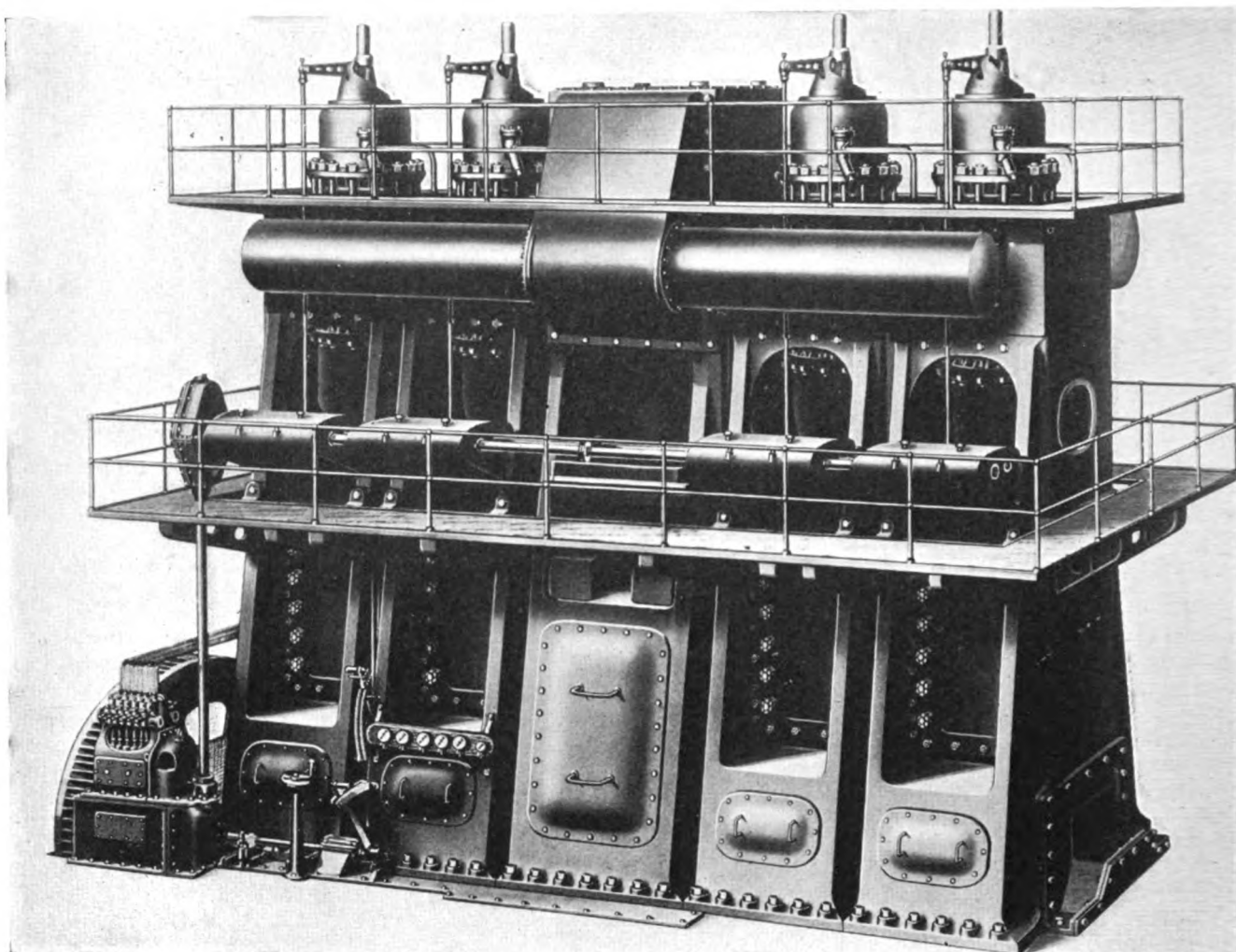


Fig. 1.—Four Cylinder, Double Acting, Two Cycle Worthington Diesel Engine Designed to Develop 2,400 Shaft Horsepower

An American Double Acting Diesel

**Worthington Pump and Machinery Corporation
Develops New Double Acting, Two Cycle Engine**

FOR some time the interest in Diesel engineering has been largely centered upon the development of the double acting motor. A number of builders, heretofore confining themselves to the single acting type, have been experimenting with double acting engines, and several have passed the purely experimental stage and are now being produced commercially, notably the Burmeister & Wain, North British, Werkspoor and M. A. N.

One of the principal obstacles in the way of a more rapid and general adoption of internal combustion machinery on shipboard has been its relatively high cost and weight as compared with steam machinery and, while we believe that the eventual general adoption of Diesel engines for moderate powers is already assured, it seems certain that, in order to utilize it where large power is required, a radical change in design is necessary.

DEVELOPMENT OF SINGLE ACTING ENGINE LIMITED

The problem of obtaining the maximum power output of a Diesel cylinder is largely a metallurgical one and until some material is found which can more successfully withstand

the action of intense heat and pressure, than the present cast iron liners, it does not appear probable that the power of the single acting engine can be very greatly increased, except by multiplication of cylinders, a method both cumbersome and costly.

The obvious solution of the problem, as at present presented, is the adoption of the double acting principle and the development, abroad, of the several types of engines mentioned shows that there is a very real demand for greater power and weight efficiency in Diesel engines.

In this country there is at this time an additional incentive for the production of this type of engine, arising from the fact that certain of the Shipping Board vessels, which it is proposed to convert to Diesel drive, cannot accommodate single acting units of sufficient power without extensive hull alterations while the fitting of double acting engines could be done with comparatively little difficulty.

Under these circumstances, the announcement, by the Worthington Pump and Machinery Corporation, of New York, of the production of an American designed, double acting Diesel engine, comes at a peculiarly opportune time.

NEW ENGINE THE RESULT OF FOUR
YEARS' RESEARCH

The Worthington Company has been building single acting Diesels for the past 12 years, nearly 100,000 horsepower being now in service in the United States, and the announcement that now, as the result of nearly four years of intensive study and research, it has produced a successful double acting engine of its own design, is bound to command attention.

The new Worthington engine, as shown by the illustrations, operates on the two-stroke cycle. The frame is cast of box section, and is entirely enclosed with oiltight doors, suitable for lubrication of all parts, under pressure, but separate completely from the cylinder so that no exhaust gas can penetrate the crank case, even should the piston rod stuffing box leak.

CONSTRUCTION OF THE ENGINE

On the frame is placed an extension to support the cylinder base which is directly bolted to the bedplate, thus releasing the frame of tensional stresses.

The top and bottom cylinders are alike; each consists of a steel shell of a shape suitable to resist the gas pressures. They are made with a substantial shoulder on the outer circumference suitable for securing the shell to the cylinder base by means of a clamping ring (Fig. 2), which, in turn, is bolted to the cylinder base by heavy studs, similar to the cylinder head studs in engines of conventional design. Into this steel shell is pressed a cast iron liner, which contains, at the open end, the ports for the introduction of scavenging air and ports for the outlet of exhaust gas. The free end of this liner rests on a heavy flange projecting inside the center bore of the cylinder base, in which bore the upper and lower cylinders are guided, thus securing perfect alinement. Around each cylinder is placed a light jacket of cast iron bolted to the top end of the cylinder and guided in the clamping ring against which it is tightened by means of a stuffing box with gland (Fig. 2).

TOP AND BOTTOM ENDS ARE INDEPENDENT SINGLE ACTING CYLINDERS

With this arrangement of cylinders, it will be seen that the top and the bottom ends of the double acting engine are really two independent single acting cylinders. The cooling water is introduced in the center of the cylinder base and moves upward through the top cylinder jacket and at the same time downward through the bottom cylinder jacket, regulated at the two outlets with independent valves. Each cylinder end has its own independent set of ports for air and exhaust.

The top cylinder has one fuel valve, the bottom cylinder two fuel spray valves furnished with suitable nozzles for directing the jet of fuel—air mixture—and so arranged that the charge does not impinge upon the piston rod.

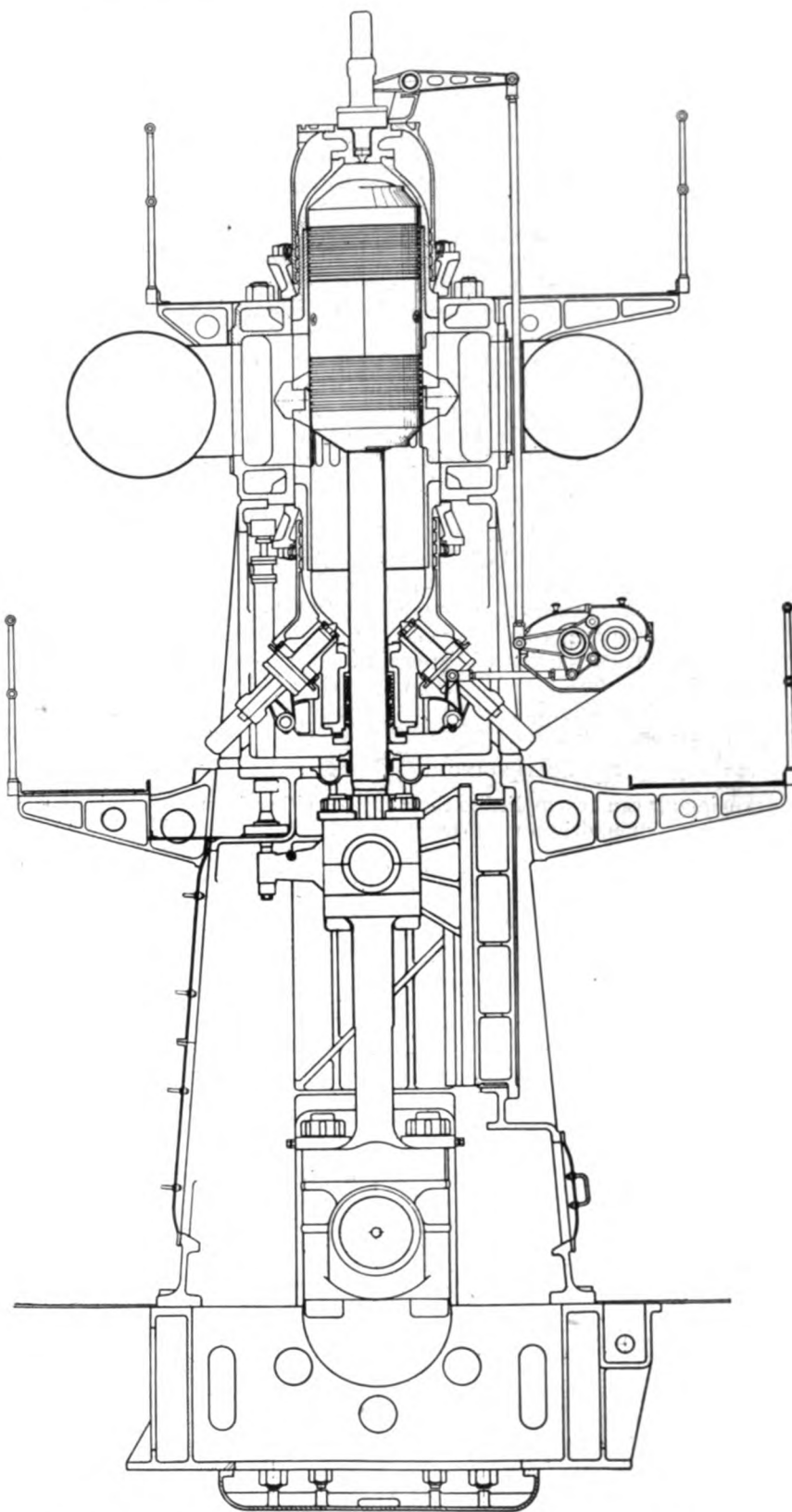


Fig. 2.—Section Through New Worthington Double Acting Engine

The piston is, in a similar way, built up of two single acting pistons, each resting on a flange on the piston rod to which it is secured with a number of heavy bolts.

Fresh water is used for cooling, as a closed system for the entire main and auxiliary machinery appears to be the most desirable arrangement for efficient cooling, cleanliness of all jacketed spaces and absence of corrosion.

VALVE MOTION

The valve motion is designed on conventional lines with one cam for each fuel spray valve. Each valve lever oscillates round an eccentric on the fulcrum shaft, which can be turned through a small angle by hand for reduction of the valve lift at low speed. The cams are symmetrical and can be used for running in both directions by rotating them through an angle of 34 degrees in relation to the main shaft. This is done in the following manner:

A spur gear on the main shaft engages an idler of considerable width, which drives a spur gear wheel keyed on a horizontal lay shaft located in the bedplate in front of the engine. This shaft can slide longitudinally in its bearings and, as the above mentioned spur gears have diagonal teeth, this motion will cause it to rotate through an angle of 34 degrees for the full travel of the lay shaft. The lay shaft passes through a sleeve which is supported in two bearings and follows the rotation of the lay shaft. The cam shaft is driven from a bevel gear bolted to the sleeve by the intermediate vertical shaft and will thereby be displaced the proper angle when the lay shaft slides from one extreme position to the other. To the forward end of the lay shaft is attached, by means of two ball bearings, a piston in the bore of which the lay shaft can freely revolve. This piston travels in a cylinder under oil pressure and is held tight against a face in the one or the other end of the cylinder for either ahead or astern rotation of the engine. Reversing is thus reduced to the turning of a four-way cock, admitting oil on one side and allowing oil to escape from the other side of the piston.

SCAVENGING

Scavenging air can be supplied to these engines either from a displacement pump, driven most conveniently by the engine itself, or by a turbo blower, driven preferably by a direct current electric motor. It is admitted to the cylinder by a light slide valve correctly timed and opening large passageways for the slowly moving air.

SERVICE PUMPS

In such marine installations where it is desired to simplify the pumping arrangement by driving the service pumps from the main engine, this beam can be extended outside of the engine for this purpose, as shown in the illustration.

Such an arrangement of service pumps will require at sea the operation of the main propelling engine only, with the possible addition of a small electric power set to provide current for steering engine, lighting, etc. This electric set, however, can, if desired, be driven from the propelling engine, and the fluctuations in voltage in the generator due to variations in speed can be eliminated by floating the load on a storage battery. Such practice is followed on certain vessels built in Europe. With the service pump equipment arranged as indicated above, the number of independent auxiliaries is reduced and the whole engine room layout simplified.

2,400 SHAFT HORSEPOWER DEVELOPED

The engine of which the foregoing is a single unit will consist of four cylinders, each 27 inches diameter by 40 inches stroke, delivering 2,400 shaft horsepower at 90 revolutions per minute.

This propelling engine is the fruit of many years of engineering and manufacturing experience in building Diesel engines by the Worthington Pump and Machinery Corporation. In developing this design, advantage has been taken of the difficulties met by the builders of Diesel engines all over the world, and to a large degree these difficulties have been eliminated. Calculations as regards weights and costs of production of this design lend much encouragement to the hope that it will go a long way toward overcoming these two

large objections to the use of Diesel engines for ship propulsion. These calculations indicate substantial savings, both in weight and in cost, over any of the present Diesel engines of similar power and with similar conservative pressure ratings as have been followed in this design.

EXHIBITION RUN AT BUFFALO

On August 28 the first Worthington double acting Diesel was given an exhibition run at the Buffalo plant of the company, which was witnessed by a large number of engineers and other interested parties who had come from New York on special cars, as guests of the builders.

This first engine consists of a single cylinder unit, the diameter being 27 inches and the stroke 40 inches. When finally assembled, with four cylinders, the output will be 2,400 shaft horsepower at 90 revolutions per minute.

New Great Lakes Steamer Greater
Detroit Goes Into Service

(Continued from page 527)

air to all inside rooms. Toilet spaces are ventilated into the stacks where possible; ventilator heads exhaust the foul air from the top of the dome. Motor-driven fans are located on the main deck and drive the air through washers into the ventilation ducts.

For fire protection a complete sprinkler system has been installed with heads in all the staterooms, throughout the public rooms and passages, over the main deck cargo spaces, in quarters below deck and in the pilot house. Fire detectors, which automatically alarm the watchman of a rise in temperature at any point, are installed all over the ship. The underside of the promenade deck is insulated with galvanized sheet steel. Fire doors in the cargo space and in passages leading to rooms are provided so as to divide the vessel into zones.

The navigating equipment, in addition to the usually adequate complement of compasses, includes a modern Sperry gyro compass and Sperry log, as well as a Haynes automatic sounding machine.

Light and power are provided by three 100 kilowatt turbo-generators, located on the main deck.

PROPELLING MACHINERY

The power plant consists of three double end and six single end Scotch boilers, fitted with Howdens forced draft and superheaters, supplying steam at 167 pounds per square inch for a three cylinder compound inclined engine, driving feathering wheels. This is the largest Corliss type engine ever built.

All boilers are 14 feet inside diameter; the single end boilers being 10 feet 6 inches long inside and the double end, 20 feet 6 inches long inside. The furnaces are 54 inches inside diameter, of the Morison type. The boilers are in three separate compartments; there being 4 fire holds and 4 bunkers extending athwartships.

The main engine has a high pressure cylinder 66 inches in diameter and two low pressure cylinders each 96 inches in diameter, with a stroke of 108 inches. The cylinders are arranged with the high pressure cylinder between the two lows. The valves on the high pressure cylinder are of the poppet type with Sickles gear; on the low pressure cylinders they are of the Corliss type.

The wheels are of the feathering type, designed to operate at 30 revolutions a minute. They are 32 feet 9 inches outside diameter, with 11 floats, each 14 feet 10 inches long by 5 feet wide, of curved steel. The centers are of cast steel, arms and braces of forged steel, rims and cross ties of rolled steel.

Propeller Guiding Devices

Latest Developments of the Contra-Propeller and Its Application to Single and Twin Screw Vessels

By Dr. E. Foerster

In order to describe the present state of the development of contra-propellers the following information regarding propeller guiding devices has been compiled.

Although the practicability of the contra-propeller, if its similarity to a water-turbine is admitted, is a foregone con-

clusion and in its present form of construction it is fully developed and ready for the market, science, however, has not yet been able to ascertain to a certainty the actual saving obtained, and nothing like standardization has, up to now, been attained in regard to guiding devices. These

still need individual treatment in each case, based upon the characteristic data of the vessel's propulsion, and the space available between the rudder post and the hub of the propeller.

The latest series of trials, executed on a large scale at the

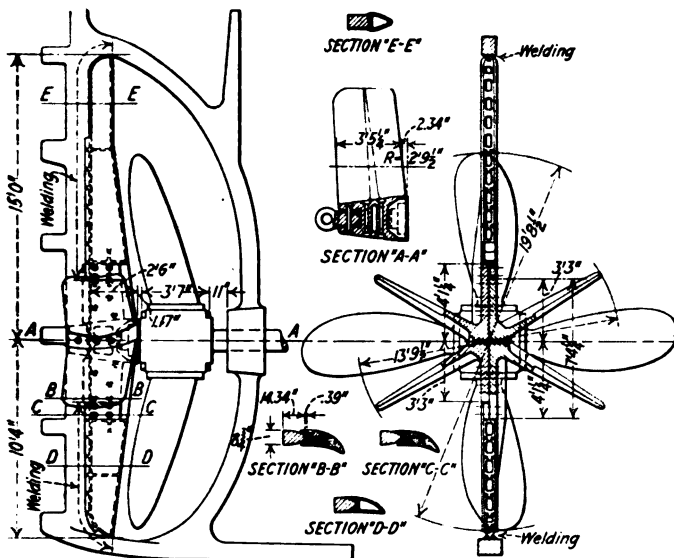


Fig. 1.—Normal Design for Contra-Propeller, as Fitted to the Hamburg American Liner Thuringia of 4,800 Horsepower

clution and in its present form of construction it is fully developed and ready for the market, science, however, has not yet been able to ascertain to a certainty the actual saving obtained, and nothing like standardization has, up to now, been attained in regard to guiding devices. These

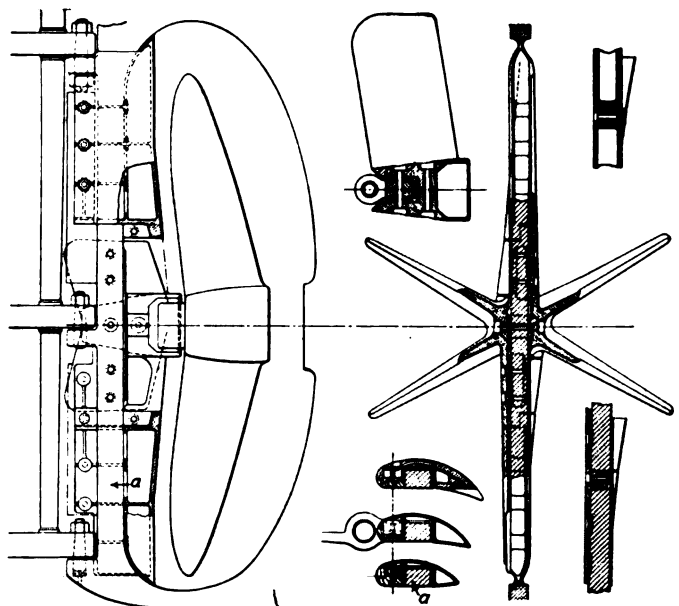


Fig. 2.—Normal Contra-Propeller in Case of Small Space Between Hub and Rudder Post

Hamburg Experimental Tank, has proved that the form of the hull also largely influences the propulsive efficiency. Special kinds of propellers, and the disk-area, pitch and

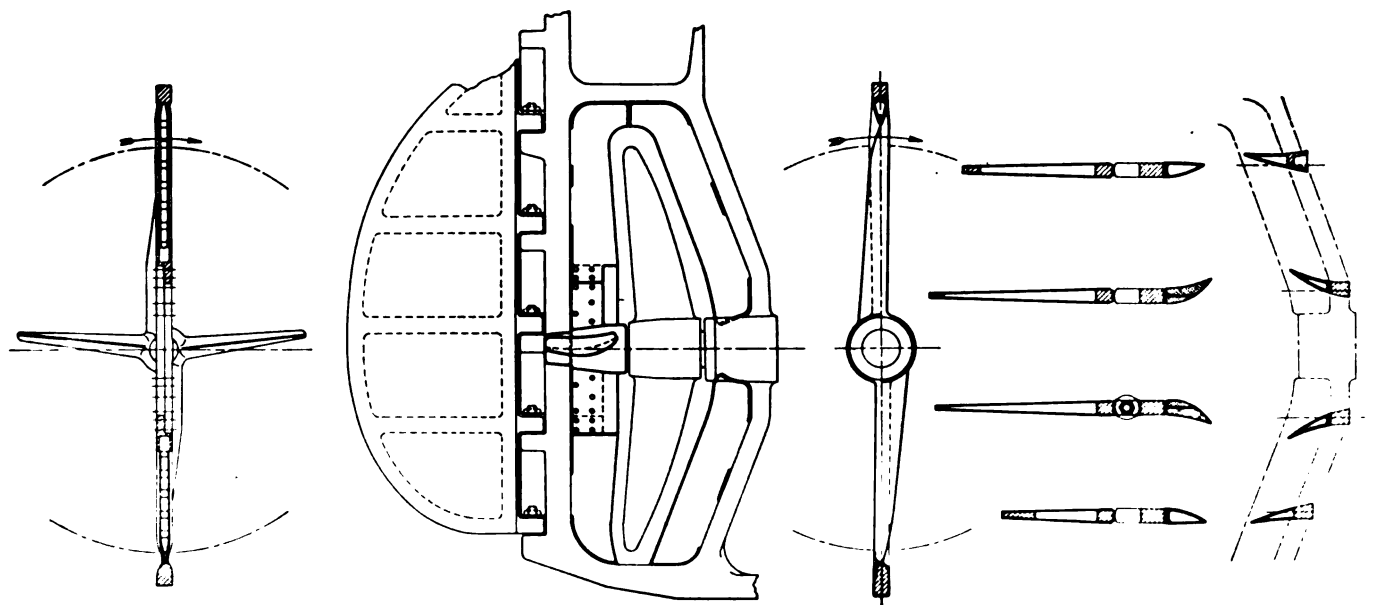


Fig. 3.—Cross Shaped Contra-Propeller with Addition of Vertical Guiding Blade Ahead of Propeller

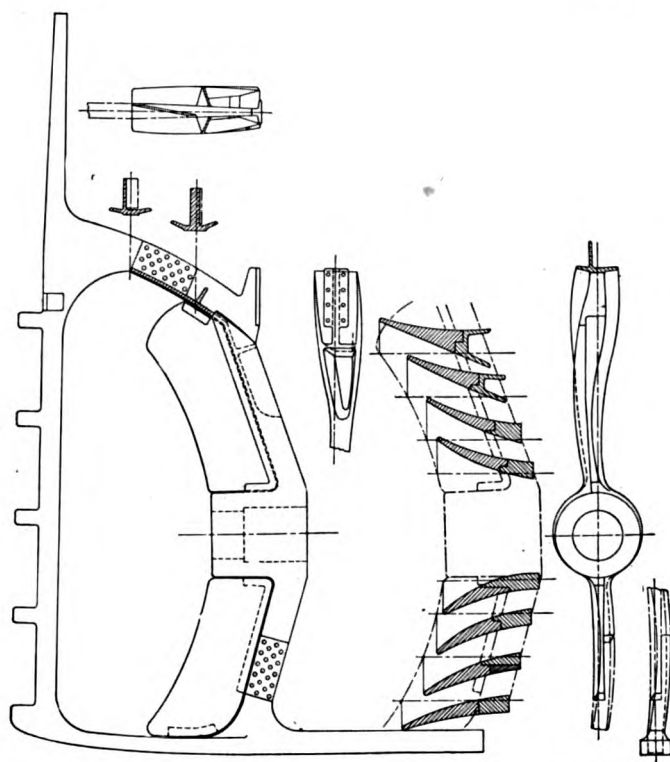


Fig. 4.—Guiding Device Ahead of Propeller as Fitted to Tug Boat

number of revolutions, must be taken into consideration in order to obtain the best results as to working efficiency, saving of fuel, etc., by propeller guiding devices.

Fig. 1 illustrates the normal design of a contra-propeller. It is the largest specimen built up to the present time, having about 20 feet diameter, as fitted to the S. S. *Thuringia* and the S. S. *Westphalia* of the Hamburg-America Line and constructed by Theodor Zeise. This equipment resulted in a substantial increase of speed and a diminution of the consumption of fuel. As far as the last voyages of both vessels have shown, there appears to be an improvement of from 10 to 11 percent in the economical balance of propulsion.

The design shown in Fig. 2 is of particular interest in cases where there is limited space between the hub of the propeller and rudder post.

In this case the vertical guiding blade, which is welded to the rudder post on its whole length, embraces the rudder

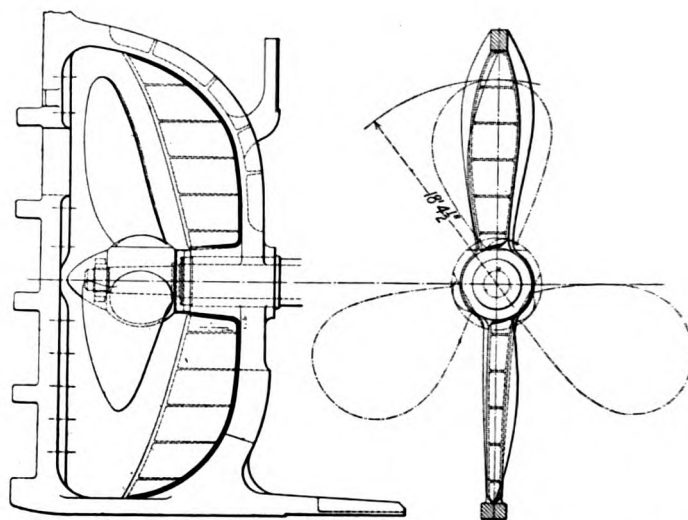


Fig. 5.—Guiding Device as Fitted to 8,000-Ton Motorship Idarwald

post, thus giving additional space for a favorable curving and fore and aft extent of the guiding blades.

The fact that the contra-propeller distinctly diminishes the pitching of the vessel, and thus favors the speed against head-seas, led to the design as shown in Fig. 3, which, at the same time, means not only a simplification of the construction and a corresponding reduction of cost but also a diminution of the dangers embodied in former prejudices, viz: the injuries to contra-propellers by floating logs, ice, etc.

Fig. 3 shows also an additional vertical guiding blade ahead of the propeller. This development is derived from the international patents of Prof. Hass and has been employed either by itself or in combination with a contra-propeller (or its vertical element).

Fig. 4 shows the design for a tug boat of the Bugsier- & Bergungs-Reederei in Hamburg, which has proved a great success.

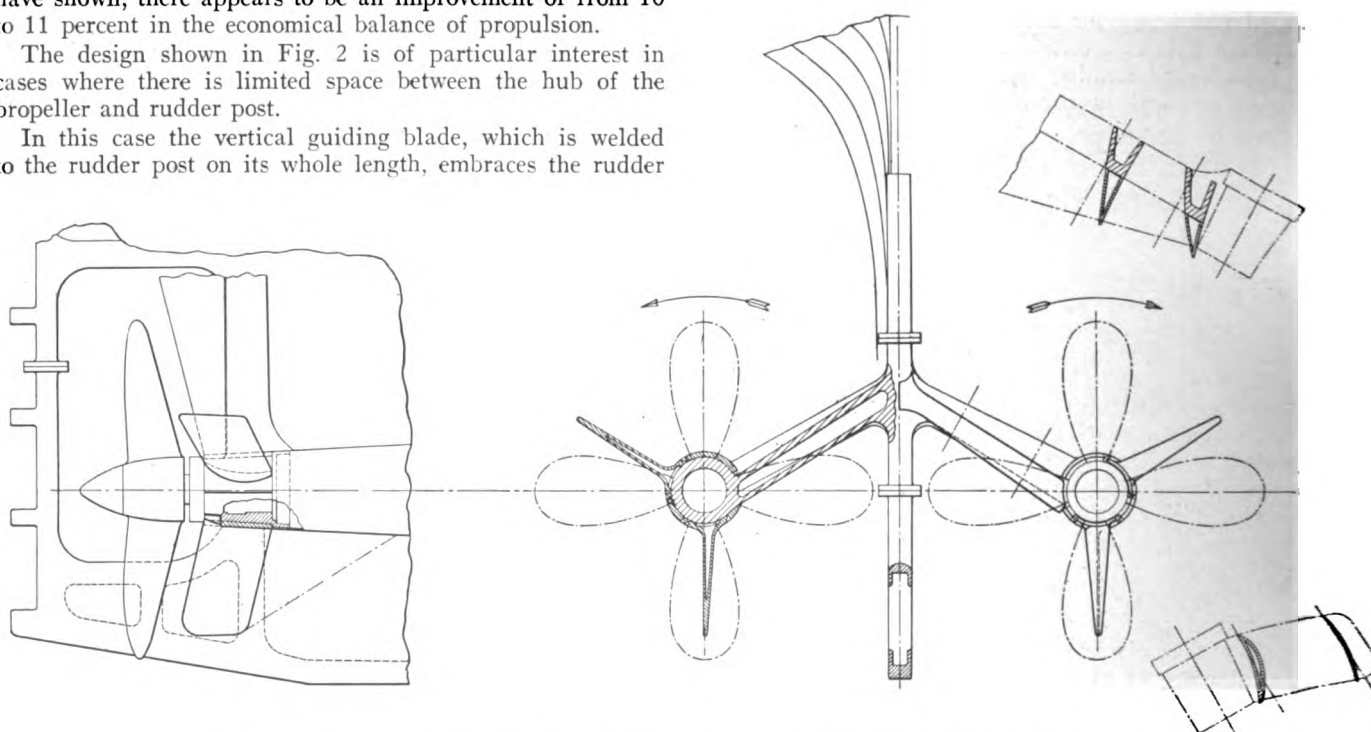


Fig. 6.—Guiding Device for Twin Screw Vessels as Fitted to S. S. Antonio Delfino

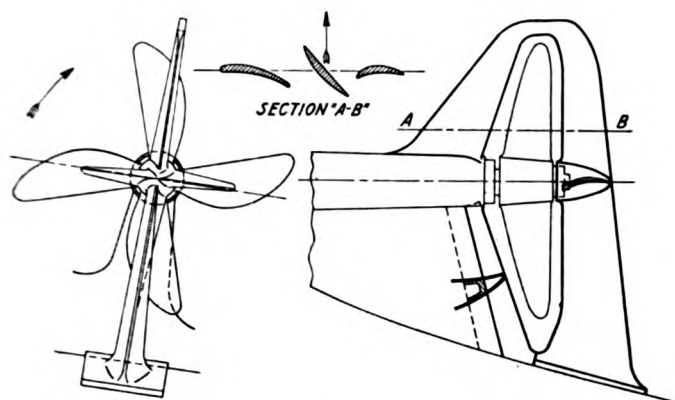


Fig. 7.—Design of Guiding Devices Combining Blade Systems Forward and Aft of the Propeller

There are also guiding devices composed of 6 blades ahead of the propeller, with a resulting saving of 10 to 14 percent of fuel. This has been adopted for single screw river vessels, where space was available for such design, and on 15 tug boats on the Mittelland Kanal, which are operated by the Prussian government.

Vertical Hass blades have been fitted to sea-going vessels with the expected success, for instance to the Hapag motorship *Idarwald* (8,000 tons) Fig. 5 and to the S. S. *Wasgen-*

wald and the *Absia*, the latter vessel's installation now being in preparation.

In the case of twin screw vessels the guiding blades are welded to the bosses ahead of the propeller as shown in Fig. 6. It was proved in the Hamburg experimental tank, that guiding devices of this kind with proper curving carefully developed by model research work may be of considerable influence on the economy of propulsion. A saving of 8 to 9 percent in power was obtained in the case of the River Plate steamer *Antonio Delfino*, for which the blades are now manufactured and are to be fitted to the bosses as shown in Fig. 6. For twin screw vessels it is necessary to examine the conditions of the working of the propeller in each case, by model research work, in order to secure the most advantageous installation with respect to diameter curving and fore and aft dimension of the blades.

In conclusion we produce in Fig. 7 a design combining both kinds of guiding devices for twin screw vessels. This at the present time is an object of investigations in the Hamburg experimental tank.

It may still be mentioned that it has also been proved to be a good scheme for single screw vessels only to combine the vertical elements of the two patent groups. This has been executed in the case of the S. S. *Wasgenwald* of 8,000 tons.

Up to the present time there are about 130 vessels fitted with propeller guiding devices of the kinds described and, according to American representatives of these inventions, many of them are also in negotiation for American vessels.



Fig. 8.—The Cast Form

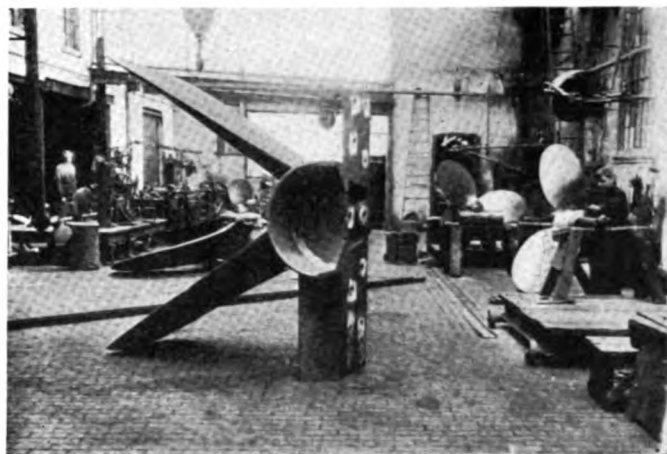


Fig. 10.—One-half of Hub and Blades



Fig. 9.—Casting Completed

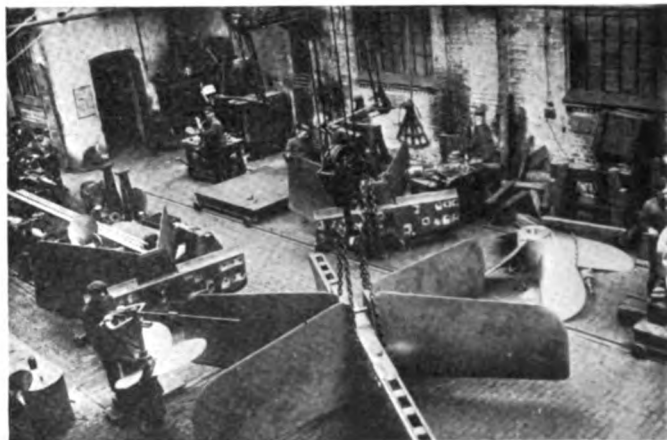


Fig. 11.—Contra-Propeller Completed in Workshop

At present there is a comprehensive series of model research experiments, ordered by a prominent American shipping company, which is aiming at the best possible results by comparing various devices for their special requirements. These

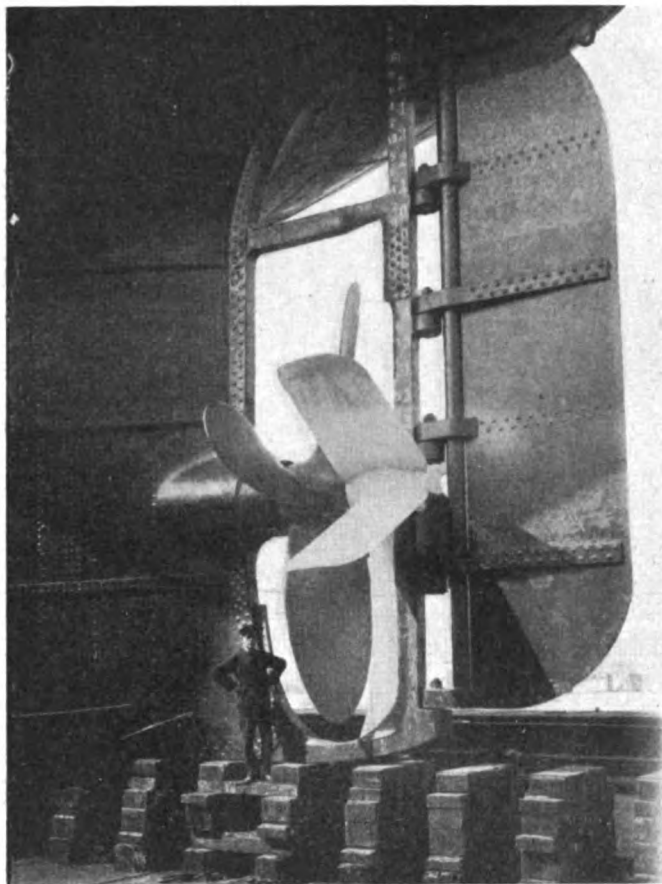


Fig. 12.—Contra-Propeller Fitted to Vessel

investigations are to be executed in the Hamburg experimental tank, which has a length of 1,000 feet, a width of 52 feet and a water depth of 23 feet.

What Is the Ultimate Economy of a Marine Boiler?

By Commander Henry C. Dinger, U. S. N.

THE best marine oil burning boilers of the present day secure an efficiency of about 82 percent at low rates and about 75 percent at high rates of combustion. Is this the limit of efficiency? Boilers on shore with air heaters and economizers secure efficiencies up to nearly 90 percent. Can not more or less the same thing be done with marine boilers?

With efficient burners and proper air regulation about the only field for improvement lies in utilizing more of the waste heat. Our uptake temperatures may vary from 500 degrees F. to 800 degrees F. Considerable heat is here lost and, if some of this can be utilized, a material gain in economy may be secured.

There are several possible lines of improvement:

- (1) Air heating.
- (2) Feed heating by waste gases.
- (3) Reduction in radiation losses.

AIR HEATING

The principal application of air heating has been the Howden system; chiefly in connection with Scotch boilers.

The air heaters are rather bulky and the gain in economy is ordinarily not over 2 or 3 percent. This installation has, however, justified itself. Other kinds of air heating devices have been used from time to time. They usually show a gain in boiler efficiency, but sometimes there is a question as to whether the additional expense is justified.

A Howden-Ljungström air preheater has been recently tested, showing rather remarkable results on a Scotch marine boiler. With oil burning, the following results were obtained:

Temperature of flue gases entering preheater 537 degrees.
Exit temperature of flue gases 195 degrees.
Temperature of air entering preheater 77 degrees.
Temperature of air leaving 426 degrees.
Boiler efficiency 87.6 percent.

The following is a description of this preheater (quoted from an article in *London Engineering*, June 29, 1924):

"The heating of the air supplied to the furnaces was effected by an air preheater of the Ljungström type, situated at the top of the uptake, and consisted of a cylindrical rotor, filled with a honeycomb arrangement of thin corrugated steel sheets, so arranged that the hot flue gases passed axially through one-half of the rotor, and the air for combustion passed in a contrary direction through the other half as the rotor slowly revolved. Two small fans on a common shaft propelled the air and gases along their respective paths. The total heating surface of the preheater was 5,110 square feet. There is in this type of apparatus no attempt at the transfer of heat from the flue gases to the incoming air through a metal wall. The rotor itself is heated by the gases, and the heat is swept off by the air for combustion."

It will be seen that in this test an efficiency of 87.6 percent was obtained with an uptake temperature of 195 degrees F. This device appears to use up about all of the available heat in the flue gases. It is probable that economizers would extract the heat from the uptake gases somewhat more efficiently, and it appears that the preheater and its extra blowers, etc., probably add more complication than would a simple economizer situated in the same place as the air heater.

FEED HEATING BY WASTE GASES

If feed heaters are installed so that the waste gases can heat the water from 200 degrees F. to 300 degrees F., a gain in boiler efficiency of about 6 percent would result. If the feed would enter the economizer at 200 degrees F., by proper arrangement of the surfaces the temperature of the gases leaving the economizer might be brought down to something like 250 degrees F. to 300 degrees F. By this arrangement the uptake temperature would be lowered 200 degrees to 300 degrees F., while the temperature of the feed water would be raised about 100 degrees F. A gain of 5 to 7 percent in efficiency might be possible. Economizers are employed on land boilers where temperatures of gases are brought down to about 300 degrees F.

Either the Scotch or the watertube boiler could readily be fitted with economizers. There would be some increase in weight and cost, but this would probably not exceed 10 percent. Watertube boilers fitted with economizers would weigh less than Scotch boilers without them.

An economizer fitted in the uptake of a marine boiler would add comparatively little complication. If an efficient economizer were fitted, one that would bring the temperature of the gases down to 300 degrees F., air heaters in addition would not be justified. However, if the double casing of the smoke pipe is used for the air intake, the air will be somewhat heated.

The latest types of oil burners, when properly operated, give almost perfect combustion, and the excess air can be brought down to something like 10 to 15 percent, so that no great economical improvement can be looked for in the burners. An appreciable loss is caused by air leaks from the fireroom into the boiler in the case of watertube boilers; but

with tight casings or with Scotch boilers, this loss is slight. With oil burning, losses due to incomplete combustion, excess air, air leakage and radiation, in best marine boiler practice are not over 10 percent. The largest of these items is radiation loss. This can be reduced by fitting improved insulation on the casings and also by using larger boiler units, since the larger the boiler the less exposed surface in proportion to boiler capacity. The largest marine express boilers built in this country contain about 11,000 square feet of heating surface, and will supply steam for about 11,000 horsepower at the engines.

By using such large units and by improved insulation, the boiler losses, due to radiation, may be reduced by several percent of the total heat supplied. So that outside of uptake losses, which now are about 10 to 15 percent, the other losses may be reduced to about 8 percent.

If by employing economizers the uptake temperature can be brought down from 600 degrees F. to 300 degrees F., a gain in boiler efficiency of about 6 percent could be secured. A boiler efficiency of 90 percent would be a practical possibility with oil fired boilers. If 90 percent efficiency is a practical possibility, why should we be satisfied with 75 to 80 percent efficiency?

EXTRA COMPLICATIONS

For express boilers the economizer can be fitted by merely introducing a few extra rows of tubes and providing circulating arrangements for causing the water to pass through these tubes before entering the general water space of the boiler. On other boilers special economizer elements would have to be fitted in the uptakes. The surface required would not be more than about 20 percent of the boiler heating surface, and the saving effected would easily justify the extra weight and expense entailed.

PAST HISTORY OF ECONOMIZERS

The fitting of economizers on marine boilers has been held in check largely by reason of the unfortunate experience, some twenty years ago, when Bellville boilers were used. These boilers employed economizers, but, due to corrosive action of the feed water, the tubes soon corroded, thus causing trouble. However, since then methods of treating boiler feed water have been developed so that corrosion can be avoided. Other types of marine boilers have from time to time employed feed heaters or economizers, but as a rule these have been badly arranged so that pitting and corrosion took place.

Economizers can be arranged so as to allow the air and corrosive gases, given off by the feed water while being heated, to be conducted away from the generating tubes of the boiler proper. By this means and by proper treatment of boiler feed water the corrosion can be avoided. This has been done successfully on land boilers, and it can be done on marine boilers. It would appear that a 5 to 6 percent increase in boiler efficiency should be a sufficient incentive, but, somehow, it has not worked out that way.

HOW MUCH SUPERHEAT SHOULD BE CARRIED?

Superheat has been introduced to a considerable extent and the question of the limiting temperature is a pertinent one. 550 degrees F. can be used safely with steel or composition pipe fittings, and this temperature is safe to use on composition turbine blading. The standard line of pumps and auxiliaries can handle this initial steam temperature without any serious trouble. However, bronze fittings will not stand a much higher temperature than this with safety, nor will the ordinary line of auxiliary machinery handle a higher temperature without trouble. If more than 550 degrees F. is used, steam pipe fittings and high pressure ends of turbines should be made of steel, while steel or monel metal should be used for blades of initial stages. This is

difficult and expensive, and the extra expense will probably be a sufficient deterrent to prevent high superheat being used on board ship. A pressure of 250 pounds, and 550 degrees F. temperature can be assumed as a good practical point to stop at. With higher pressures it is difficult to get tight valves and joints on board ship.

Superheating does not increase the boiler efficiency, but increases the engine efficiency. The first 100 degrees of superheat for an engine taking steam at 250 pounds will increase the efficiency of the engine about 9 percent, while the second 100 degrees superheat will probably not add more than 6 percent. High superheat is justified, if material that can take care of it is provided. It appears that by paying attention to securing a tight boiler casing, using efficient lagging and without employing economizers or air heaters, a boiler efficiency of about 83 percent can be secured at about $\frac{1}{3}$ full capacity. By using ordinary Howden's draft this may be brought up to 84.5 percent; by using the special Ljungström preheater 87.5 percent efficiency may be obtained, while by using efficient economizers 90 percent can be reached. Under the 90 percent condition the losses will be made up about as follows:

	Percent
Loss due to hydrogen and moisture.....	2
Loss due to incomplete combustion	1
Loss due to excess air	2
Loss due to waste gases	2
Loss due to radiation	3
Total.....	10

It is not believed possible to reduce the sum total of the above losses materially, so that 90 percent efficiency appears to be the practical limit of boiler efficiency. Efficiencies as high as this have been secured on special tests. The 90 percent efficiency would be secured while burning about 0.3 pound of oil per square foot of heating surface. A reduction in efficiency of several percent would result at high rates.

The best results obtained with a marine turbo-reduction gear for saturated steam correspond to a water consumption of about 10.5 pounds of water per horsepower hour. With a boiler efficiency of 90 percent an actual evaporation of about 16 pounds of water per pound of oil can be obtained. Under these conditions the oil per shaft horsepower per hour will be about 0.7 pound for main engines only, and if 10 percent is allowed for auxiliaries, the result should be 0.77 pound per shaft horsepower for all purposes. This result can actually be secured, if the installation is well designed and properly operated. In practice very few vessels approach this result within 50 percent. Is it worth while to take steps to cut out this waste, which is avoidable?

A large part of the waste can be avoided by fitting marine boilers with economizers or air heaters, and by seeing that radiation losses are reduced to a minimum.

Haskelite Used for Interior Bulkheads of the Steamship Boston

On page 400 of our July, 1924, issue, in an article describing the steamship *Boston* of the Eastern Steamship Company, it was erroneously stated that "the passageway and stateroom bulkheads are of Roddis-wood throughout." Haskelite was used for the interior joiner bulkheads of this vessel, instead of the material mentioned.

SAFETY CONGRESS.—The thirteenth annual Safety Congress of the National Safety Council will be held in Louisville, Ky., September 29 to October 3. Meetings of the Marine Section will be held on September 30 and October 1.

Effect of Wind and Waves on Propulsion of Ships*

Observations of Weather Encountered and Behavior of Different Types of Vessels on Ocean Voyages to Determine Causes of Loss of Speed in Ships at Sea

By J. L. Kent

THIS paper gives an account of the effect of weather, etc., on the speed and behavior of four ships from data obtained by observations made during four ocean voyages, viz.:

- (i) On a passenger steamer—The Canadian Pacific steamship *Montcalm*, to and from St. John, N. B., Canada, and Liverpool.
- (ii) On an express cargo steamer—The Furness-Withy Company's steamship *London Mariner*, from London to Queenstown.
- (iii) On two oil-tank steamers—The Eagle Oil Transport Company's *San Gerardo*, from Tilbury to Tampico (Mexico), and *San Tirso*, between Tampico and Rotterdam (Holland).

The principal dimensions and other particulars of these four ships are given in Table I.

of the four ships carried a Walker's Cherub Log (Mark II) which usually recorded very well in a head sea, although in a following sea its record was somewhat irregular. *Shaft horsepower*. The *Montcalm*, *London Mariner* and *San Gerardo* were each driven by steam-turbine machinery, and were fitted with Hopkinson-Thring torsionmeters. As the ship rolls and pitches, very considerable variations in propeller torque occur. The torque when the vessel remained on an even keel for 10 to 15 seconds (which usually occurred periodically) was recorded, and this value has been taken in working out the mean power required to drive the ship under the weather conditions obtaining at the time.

The *San Tirso's* propelling plant was a quadruple expansion reciprocating engine, and an approximation to the indicated horsepower was obtained at each observation by recording the mean inlet steam pressures at each cylinder. The

TABLE I.—PRINCIPAL SHIP DIMENSIONS AND OTHER PARTICULARS

Ship	S.S. <i>Montcalm</i>	S.S. <i>London Mariner</i>	S.S. <i>San Gerardo</i>	S.S. <i>San Tirso</i>
Firm	Canadian Pacific Steamships	Furness-Withy & Company	Eagle Oil Transport Company	Eagle Oil Transport Company
Type	Passenger ship	Express cargo ship	Oil-tank steamer	Oil-tank steamer
Length (B. P.)	546 feet	450 feet	530 feet	420 feet
Breadth	70 ft.	57 feet 9 inches	64 feet	54 feet 6 inches
Draft (mean)	24 feet 6 inches	27 feet	30 feet 9 inches	26 feet 9 inches
Displacement	19,670 tons	14,660 tons	25,700 tons	13,700 tons
Propelling plant	Brown Curtis steam turbine with double-reduction gearing	Brown Curtis steam turbine with single-reduction gearing	Steam turbine, double-reduction gearing	Quadruple expansion reciprocating engines
Number of propellers	2	1	1	1
Propeller particulars				
Diameter	19 feet 6 inches	18 feet 9 inches	21 feet 0 inches	18 feet 6 inches
Pitch	19 feet 6 inches	17 feet 3 inches	18 feet 9 inches	16 feet 3 inches
Blade area	120 square feet	118 square feet	150 square feet	110 square feet
No. of blades	4	4	4	4

Observations were made at approximately regular intervals during the daylight hours, the following data being collected:

Wind Speed, relatively to the ship. *Wind Direction* relative to the ship. *Wave Direction*. *Wave-height*. This estimation was frankly a guess, but it is thought that the comparative heights at least are reliable. *Period of Encounter*. This is the time elapsing between the vessel meeting successive waves. *Ship's Speed*. Each

shaft horsepower of the *San Tirso* has been assumed to be 0.8 times the power obtained as described above.

The following data were also collected: *Propeller revolutions*, *pitching angle*, *pitching period*, *rudder angle* (in each ship it was necessary for the quartermaster to use helm constantly in order to keep the vessel on her course), *course* and *rolling*.

ANALYSIS OF DATA

The wind speed recorded by the gage was constant only on

TABLE II.—WIND SPEEDS AND WAVE DIMENSIONS ON NORTH ATLANTIC OBSERVED ON S.S. *MONTCALM* IN MARCH, 1922

Date, 1922	Observation Number	Particulars of Wind					Ship's Course	Particulars of Waves			From Formula			Weather Conditions
		True Mean Speed Knots	Maximum Fluctuation of Speed Percent	Wind Force on Peaufort Scale		Direction		Length Feet	Maximum Height Feet	Calculated Maximum Wave Slope Degrees	Wave-length ($L = 4.81 W^2$) Feet	Wave-height ($H = .391 L^{.5}$) Feet		
				From Observation	From Deck Log									
March 2.....	7	49.7	..	10	9	N.W.	W.	N.W. x W.	663	35/40	10.2	880	36.3	Heavy head sea. Furious wind and snow squalls. Cross swells.
March 2.....	8	46.4	23	10	9	W.	W.	W. x N.	563	30/40	11.3	802	34.0	
March 2.....	9	44.5	39	9/10	8	W. x N.	W.	W.N.W.	519	30/40	12.3	760	32.5	
March 11....	19	16.1	22	4/5	3	E.	E. x S.	E. x S.	66	1/2	4.1	196	11.8	Smooth sea. Occasional snow flurries. Steady wind increasing in force.
March 11....	21	17.8	26	5	3/4	E. x S.	E. x S.	S.E. x S.	98	5	4.0	226	13.0	
March 14....	29	23.0	65	6	6/5	N.W.	E.	N.W.	102	10/20	27.6	315	16.9	Heavy quarterly swell. Rough following sea. Light wind increasing in force.
March 14....	32	30.4	..	7/8	5/3	W. x N.	E.	W. x S.	96	15/20	35.0	455	22.2	
March 15....	35	2.5	16	1	1/2	N.	E.	E.	886	8/10	1.8	19	1.7	Moderate sea and slight confused swell. Light wind, rainy.
March 16....	37	23.8	21	6	5/6	E. x S.	E.	E.	236	8	6.2	331	17.5	Confused sea and swell. Increasing wind.
March 16....	40	30.4	19	8/7	6/7	S.E.	E.	S.E.	264	8/15	7.8	456	22.3	

*W = wind speed in knots.

WIND AND WAVES ENCOUNTERED ON NORTH ATLANTIC

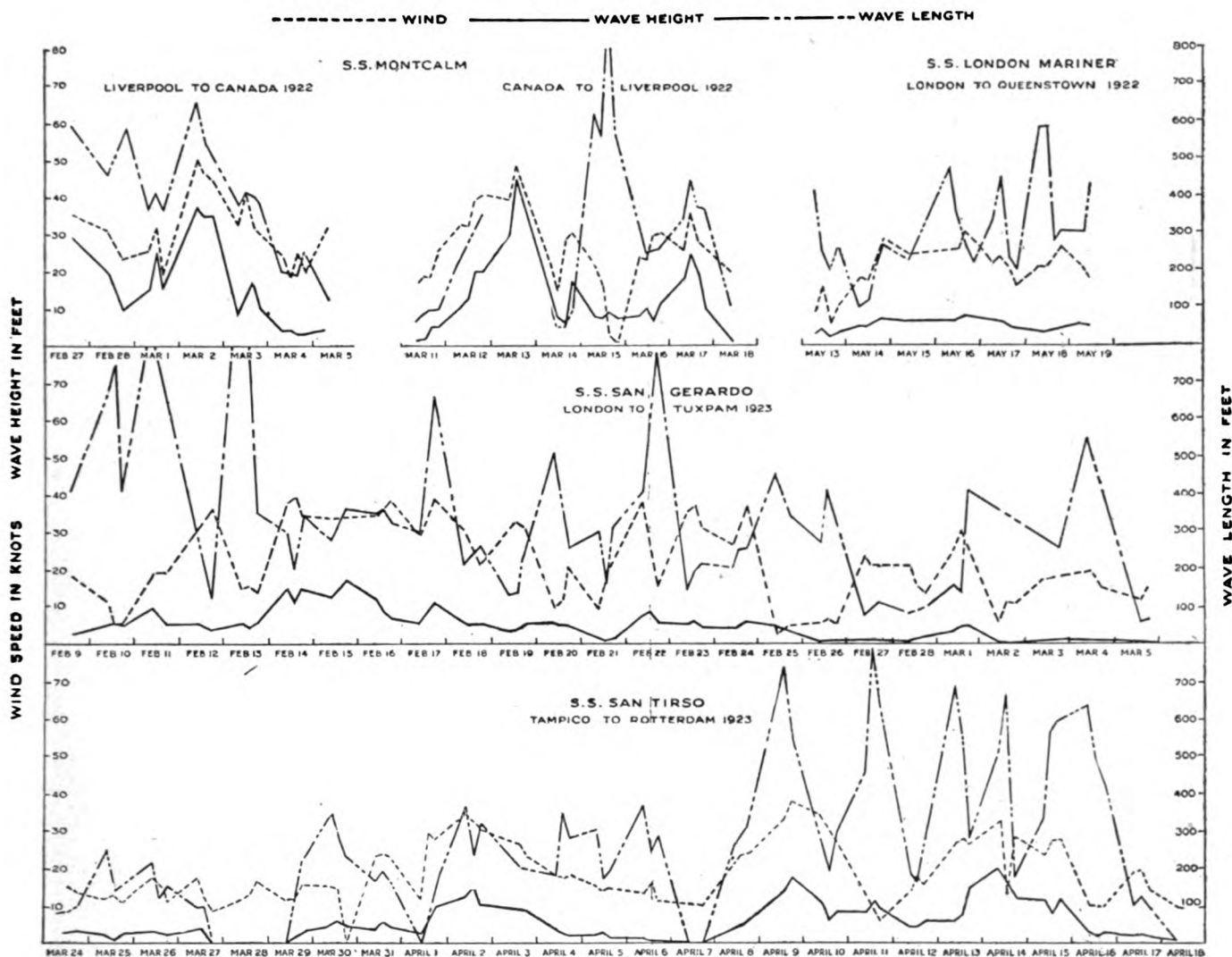


Fig. 1

comparatively few occasions. The wind was usually blowing in a series of squalls. The percentage fluctuations of wind speed during squalls and lulls over the steady wind speeds are given in Tables II and III.

The fluctuation in wind direction given by the vanes was usually very small.

The wave-lengths can be obtained when the ship's speed, period of encounter and direction relatively to the waves are

known, assuming the usual formula for period and speed of gravity controlled waves and together with their estimated heights, are given in Tables II and III, and are shown graphically in Fig. 1.

The connection between the wind and the waves produced by it is illustrated in Fig. 1, which gives the true wind speeds together with the wave-lengths and heights recorded at the same time.

TABLE III.—WIND SPEEDS AND WAVE DIMENSIONS ON NORTH ATLANTIC OBSERVED ON S.S. SAN GERARDO IN FEBRUARY AND MARCH, 1923

Date, 1923	Observation Number	Particulars of Wind					Ship's Course	Particulars of Waves				From Formula		Weather Conditions
		True Mean Speed Knots	Maximum Speed Fluctuation Percent	Wind Force on Beaufort Scale		True Wind Direction		Direction	Length Feet	Maximum Height Feet	Calculated Maximum Slope Degrees	Wave-length ($L = 4.81 W^{.5}$) Feet	Wave-height ($H = .391 W^{.5}$) Feet	
				From Observation	From Deck Log									
February 15.. 16	34.6	..	8	4	W. x S.	W. x S.	W. x S.	370	15/20	8.5	543	25.3	Heavy swell. High sea. Very fierce wind squalls. Rain later.	
February 23.. 36	35.4	64	8	...	W.	W. x N.	W. x N.	149	5/6	6.6	558	25.8	Two swells. Steep seas. Continuous wind squalls. Overcast.	
February 23.. 38	31.4	100	7/8	5/6	W.	W.	W.	218	4/5	3.7	477	23.0		
February 24.. 39	26.8	75	6/7	...	W.	W.	W.	206	4/5	3.9	386	19.6	Rough steep sea and swell. Wind squalls. Wind moderating. Rain at end of day.	
February 24.. 41	36.1	Nil	8	...	N.W. x N.	W.	W. x N.W.	257	6	4.2	575	26.4		
February 28.. 50	21.0	23	5/7	...	S.W. x S.	W.S.W.	S.W. x S.	80	< 1	1.1	278	15.3	Slight sea. Fine and clear.	
February 28.. 52	13.5	118	4	...	W.S.W.	W.S.W.	S.W. x W.	97	2	3.6	154	9.8		

*W = wind speed in knots.

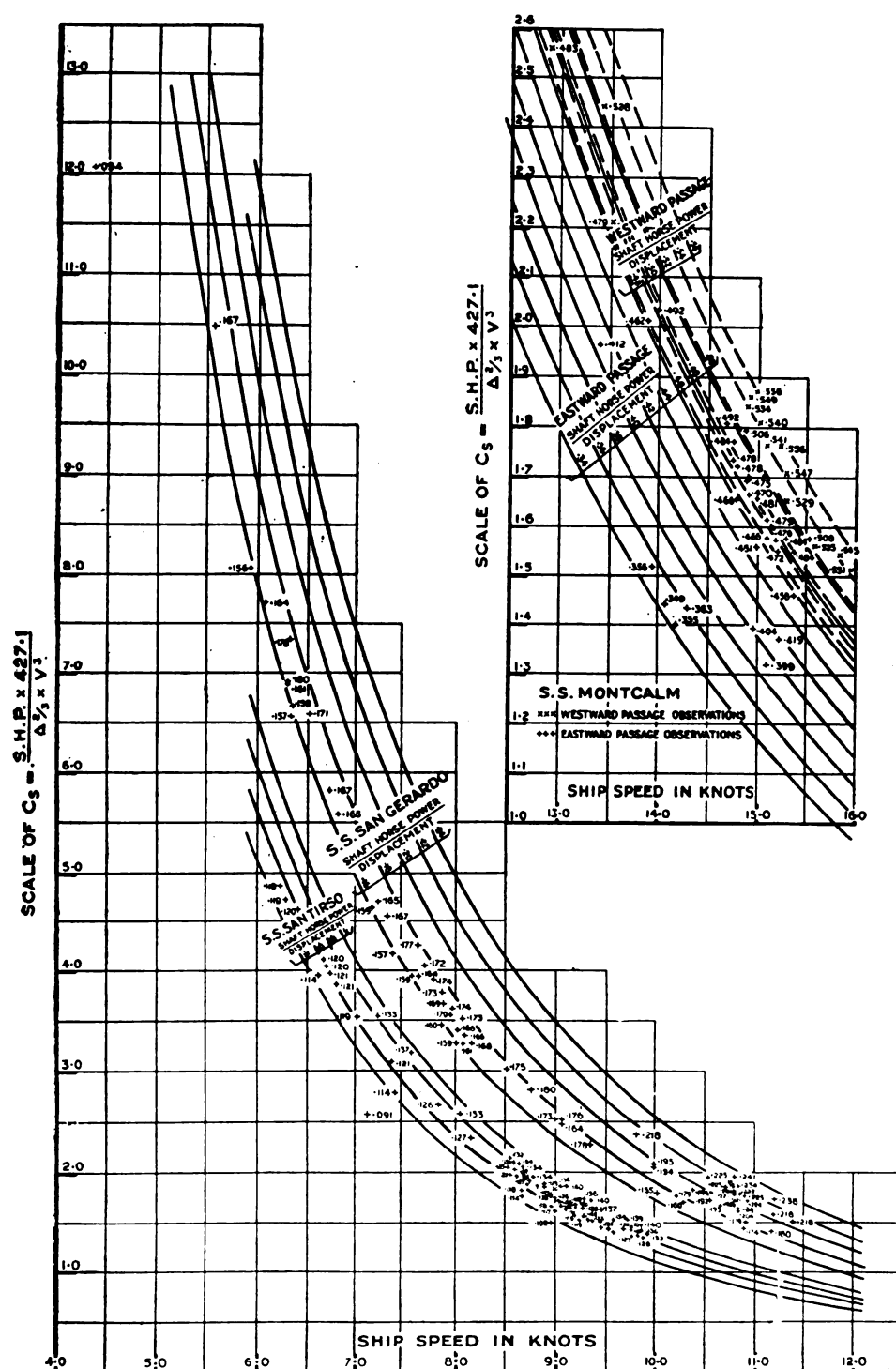


Fig. 2.—Speed and Power on Voyage for T. S. S. Montcalm During February and March, 1923, and S. S. San Gerardo During February and March, 1923, and S. S. San Tirso During March and April, 1923. Crosses Indicate Power and Speed Obtained at Each Observation. Numbers Indicate S. H. P. Per Ton Displacement at Each Observation.

Under the conditions prevailing on the Atlantic passage during these observations, the wind which the ship encountered was rarely steady, and was changing almost hourly both in force and direction (see Fig. 1). It is, however, probably sufficiently correct in general to assume that on the North Atlantic route the wind speed may be taken as a criterion of the size of the waves produced by it, and although the actual wave dimensions will not always be exactly the same for the same wind speed, they will always approximate sufficiently to the same dimensions to provide a basis for comparison.

APPEARANCE OF WAVES

A perfectly regular ocean swell, undeformed by smaller waves, was never seen during these voyages; but well-defined swells of fairly constant wave-length and height were frequently met.

A most marked feature in the appearance of the sea on March 2, 1922, and other days was the hummocks of water on top of the swell. These hummocks piled up in places and broke by falling. They are apparently caused by two or more swells travelling in different directions and crossing each other, and on March 12 and 13, 1922, when the S. S. *Montcalm* was encountering three distinct swells, one meeting the ship "head on," a second on the port bow, and a third swell overtaking the ship on her starboard quarter, reached heights of over 50 feet, and produced very heavy rolling and pitching of the ship.

When the wind blows continuously in a series of violent squalls, the swell produced consists of groups of waves varying in height periodically from a maximum to a minimum, each of these groups following each other at approximately the same speed, and in the same direction.

SPEED AND POWER ON VOYAGE

To correct approximately for the change in tonnage between successive observations, the assumption was made that the loss in weight (obtained from the drafts at the beginning and end of each voyage) occurred uniformly throughout the voyage.

As neither shaft horsepower nor displacement remained the same during the whole voyage, to obtain a true comparison of the effect of weather on the ship's speed day by day values of

$$C_s^* = \frac{S.H.P. \times 427.1}{\Delta^{2/3} \times V^3}$$

have been worked out from the data obtained during each observation. These values of C_s have been plotted to a base of ship's speed, and are given in Fig. 2 for the *Montcalm* and *San Gerardo*.

In a smooth sea in fine weather the values of C_s are generally approximately the same over a small speed range of two or three knots. It will be seen from Fig. 2 that under voyage conditions this C_s value varies very considerably. To take account of the change in shaft horsepower and displacement, the comparison has been made for the same shaft horsepower per ton of displacement (i.e., at the same

△ The sea-water temperature was taken during the observation periods, and the C_s values have been corrected to a uniform temperature of 55 degrees F.

TABLE IV.—POWER AND SPEED OBTAINED ON S.S. MONTCALM

Observation Number	S. H. P. Δ	Speed Knots	S. H. P.		Revolutions per Minute		$S.H.P. \times 427.1$ $\Delta^3 \times V^3$ C_s	Calculated			
			Port Shaft	Starboard Shaft	Port Shaft	Starboard Shaft		Wake Fraction		Screw Efficiency	
								Port	Starboard	Port	Starboard
3	0.545	15.85	4,720	5,560	83	84	1,540	0.49	0.61	0.658	0.621
6	0.531	14.9	5,190	4,810	84.1	83.3	1,838	0.41	0.39	0.649	0.657
13	0.551	15.97	4,535	5,435	81.6	84.5	1,515	0.51	0.55	0.659	0.632
15	0.541	15.1	4,660	5,055	86.7	86.4	1,760	0.23	0.31	0.686	0.670
29	0.450	15.0	4,450	4,890	85.0	85.2	1,560	0.25	0.32	0.682	0.669
36	0.507	14.88	5,000	5,400	83.5	86.8	1,795	0.41	0.31	0.649	0.661
36	0.404	14.97	3,875	4,185	80.6	80.5	1,395	0.34	0.40	0.680	0.667
41	0.412	13.40	3,970	4,125	77.9	78.4	1,962	0.34	0.34	0.657	0.653
45	0.399	15.11	3,580	4,170	78.7	80.1	1,320	0.39	0.44	0.681	0.662

values); and in Fig. 2 curves have been drawn for a number of such values. Each of the spots obtained from the observation data lies close to its particular calculated curve; such small differences as occur being well within the limits of error in observation. Each curve of shaft horsepower per ton of displacement corresponds to a C_s value at one speed in fine weather for the particular ship, at one displacement and given shaft horsepower. As the weather gets worse the retarding forces increase, the ship's speed diminishes, and the C_s value appropriate to any given weather condition will lie on the particular curve.

Fig. 2 and Tables IV and V bring out some interesting facts. Under any given rough weather conditions the percentage increase in C_s value over the smooth water value is a measure of the increase in power necessary to maintain the ship's smooth water speed. For example, in the S.S. *Montcalm* on March 3, 1922, the ship's speed was 12.9 knots, and the $C_s = 2.59$. In smooth water under the same conditions of loading, the C_s is approximately 1.22; so that on that date more than twice the power was necessary to drive the ship at 12.9 knots than would have been required to maintain that speed in smooth water.

Similarly, for the *San Gerardo*, on February 15, 1923, the C_s equalled 10.5, and the speed was 5.56 knots. The smooth water speed for the ship under the same conditions of loading and power was 10.9 knots, and $C_s = 1.9$. That is, on February 15 about five times the power was necessary to obtain 5.56 knots than would have been required to maintain this speed in smooth water. Similar examples occur in the data obtained for the other ships. These figures point to the desirability of a clear understanding of the various factors causing loss of speed at sea, and any attempt to assess the relative importance of these factors deserves attention.

POWER DELIVERED BY THE PROPELLER

When the various retarding forces due to the weather begin to lessen the ship's speed, it follows that the true slip of the propeller becomes greater if the revolutions are kept the same, as is generally the case in practice. This usually means that the propeller efficiency is less, the useful power developed is smaller, and more power is wasted in the propeller. To obtain some idea of the amount of this alteration in screw efficiency the assumptions have been made that 95 percent of the mean shaft horsepower recorded was actually delivered at the propeller, the remaining 5 percent being absorbed by shaft friction, etc.; also that the relative rotative efficiency was unity, and the hull efficiency as obtained by model experiments in smooth water. On these assumptions, from the known propeller dimensions, and the revolutions and ship's speed obtained by observation, the mean wake fractions for each screw have been determined—using Froude's propeller data—and are given in Tables IV and V. From these fractions, the true slips and screw efficiencies have been obtained. These figures show that in smooth water about one-third the shaft horsepower was lost in the propellers of the S.S. *Montcalm*, and over one-half in the case of the S.S. *San Gerardo*. In rough weather these losses are usually increased.

LOSS OF PROPELLER EFFICIENCY DUE TO RUDDER

In addition to the loss of propeller efficiency due to the retardation of the ship's speed by the weather, another cause of loss of power by the propeller is frequent use of the rudder at large angles, especially when this occurs in the case of single-screw ships.

It was noticed also that in the twin-screw ship *Montcalm*, when the wake fractions for each screw differed considerably as on March 2, the rudder was turned to the same side as the screw with the greater wake fraction and lower screw efficiency.

TABLE V.—POWER AND SPEED OBTAINED ON S.S. SAN GERARDO

Observation Number	S. H. P. Δ	Speed, Knots	S. H. P.	Revolutions Per Minute	$S.H.P. \times 427.1$ $\Delta^3 \times V^3$ C_s	Calculated	
						Wake Fraction	Screw Efficiency
7	0.159	7.17	2,560	57.0	4.65	0.47	0.488
13	0.158	5.96	2,315	55.4	8.64	0.40	0.445
17	0.171	6.52	2,696	56.1	6.60	0.55	0.426
23	0.165	7.14	2,690	55.1	4.70	0.78	0.450
23	0.167	6.75	2,608	55.8	5.82	0.54	0.440
25	0.158	8.11	2,600	56.2	3.36	0.85	0.451
29	0.166	8.05	2,572	56.1	3.41	0.82	0.455
44	0.194	10.40	2,938	60.3	1,840	0.62	0.510
52	0.198	10.00	2,904	59.8	2,082	0.60	0.501
59	0.225	10.50	2,987	61.7	1,780	0.85	0.536
61	0.223	10.52	2,955	61.5	1,960	0.79	0.537

TABLE VI.—PITCHING AND ROLLING DATA, S.S. MONTCALM

Observation No.	Pitching				Rolling				Percentage Variation on Torque			
	Period		Maximum Angle		Period		Maximum Angle		Pitching		Rolling	
	Seconds	Degrees	Oscillations per Cycle	Period of Encounter	Seconds	Degrees	Oscillations per Cycle	Period of Encounter	Port	Starboard	Port	Starboard
3	6.6	5.7	6-11	5.9	13.0	12.8	1.2	13.0	22	22	47	47
13	7.5	8.6	10.1	Irreg.	9.4	11.1	8.0	11.1	45	31	29	47
15	7.9	4.7	6	8.6	13.0	12.8	1.2	13.0	13	13	47	47
32	8.8	13.6	3.2	6	24.0	16.9	12.8	16.9	13	13	47	47
34	10.8	13.6	4.2	Irreg.	7.15	15.0	16.4	15.0	13	13	47	47
36	6.8	8.0	3.2	6	7.25	14.4	17.4	8.4	13	13	47	47
39	6.2	2.6	5.6	4.5	17.4	17.4	1.0	Irreg.	13	13	47	47
42	6.4	3.4	8	6.3	16.6	16.6	4.2	7	13	13	47	47
44	5.8	6.2	2.2	7	5.3	8.0	12.0	2.6	13	13	47	47

* C_s has been corrected for temperature of sea to 55 degrees F.

* Combined rolling and pitching.

VARIATION IN SHAFT HORSEPOWER

The torque readings given by the torsionmeter varied considerably from revolution to revolution when the ship was rolling or pitching.

It will be seen that, generally speaking, the greatest fluctuation in torque occurs in the twin-screw ship when the ves-

sel is rolling, and in the single-screw steamers when pitching, and in addition the amount of fluctuation in power is roughly proportional to the maximum rolling or maximum pitching angle.

PITCHING AND ROLLING

Continuous records of the pitching angles and pitching periods of each of the ships were obtained during every observation, and observations were also made by means of "horizon apparatus" of the angles and periods of roll. The maximum pitching and rolling angles so obtained, together with the pitching and rolling periods and periods of encounter, are given in Tables VI and VII.

Except in comparatively few instances, when the sea was confused and no particular swell distinguishable, it was always possible to clearly determine the predominate swell, and the ship met this swell usually on the port or starboard bow.

The natural pitching periods of each of the ships was determined approximately from pitching records, when the waves were too small in height and too quick in period to impose their motion on the ship, which then performed oscil-

TABLE VII.—PITCHING AND ROLLING DATA, S.S. SAN GERARDO

Observation Number	Pitching				Rolling				Percentage Variation in Torque	
	Period Seconds	Maximum Angle Degrees	Oscillations per Cycle	Period of Encounter Seconds	Period Seconds	Maximum Angle Degrees	Oscillations per Cycle		Pitching	Rolling
10	9.6	2.9	Irregular	10.0	10.4	6.2	6-7		94	22
12	10.3	4.8	Irregular	6.5	10.0	18.9	6		29	16
15	9.4	4.8	..	7.1	10.0	15.7	7		58	30
17	9.4	3.4	..	6.7	9.5	13.2	7-8		50	13
19	8.4	2.5	..	5.4	6.4	9.8	12		27	12
22	10.5	2.8	..	4.8	11.3	8.9	Irregular		44	10
25	10.5	2.5	..	3.4	9.6	4.2	6		12	6
34	10.8	3.4	..	8.9	10.2-11.5	23.6	5		28	8
36	9.2-10.0	3.1	..	3.95	10.7	13.2	6		21	8

TABLE VIII.—FORCES AFFECTING STEERING, S.S. MONTCALM

Observation Number	S.H.P.			Wind relatively to Ship		Waves			Rudder Angle and Direction Degrees
	Port Shaft	Starboard Shaft	Difference	Speed Knots	Direction Degrees	Length Feet	Height Feet	Direction Degrees	
3	4,720	5,560	840 S.	39	10 S. bow	589	10	10 S. bow	5 S.-10 S.
6	5,190	4,810	380 P.	32.5	20 P. bow	366	15	10 P. bow	15 S.-20 P.
9	4,350	4,755	405 S.	58.0	10 S. bow	517	30-40	10-30 S. bow	5 S.-15 S.
11	4,510	5,090	580 S.	56.4	Head on	419	..	0-10 P. bow	15 S.-10 P.
22	4,750	5,290	540 S.	39.9	5 P. bow	95	5	Head on	3 P.-10 P.
25	4,560	5,200	640 S.	48.6	45 P. bow	319	20	Cross-swell 20-30 P.	5 P.-10 P.
31	4,410	4,810	400 S.	15.2	45 P. bow	50	5-6	45 P. quarter	0-7 P.
35	3,960	4,410	450 S.	16.1	10 P. bow	886	8-10	Head on	0-5 P.
40	3,405	3,620	215 S.	41.7	30 S. bow	264	8-15	10 & 45 S. bow	15 S.-40

TABLE IX.—FORCES AFFECTING STEERING, S.S. SAN GERARDO

Observation No.	Wind Relatively to Ship		Waves		Direction	Rudder Angle and Direction Degrees
	Speed Knots	Direction Degrees	Length Feet	Height Feet		
1	19.1	75 P. bow	410	3	30 P. bow	5 P.-23 P.
2	13.0	10 P. bow	751	5-6	Head on	3 P.-7 P.
3	40.8	45 P. bow	119	3-5	15 P. bow	6 S.-20 S.
12	41.7	45 P. bow	303	15	45 P. bow	3 S.-7 S.
14	40.8	Head on	351	15	Head on	10 S.
21	45.1	10 S. bow	674	10-12	5 S. bow	10 P.
23	26.0	45 S. bow	261	5-6	10 S. bow	6 P.-12 S.
24	39.1	5 P. bow	131	3-4	Head on	6 P.-12 S.
29	17.8	10 P. bow	253	5	Head on	12 P.-14 S.

lations of small amplitude in its own period. The natural periods so determined were as follows:

S.S. Montcalm	7.2 seconds
S.S. London Mariner	6.8 seconds
S.S. San Gerardo	10.2 seconds
S.S. San Tirso	9.8 seconds

OBSERVATIONS ON ROLLING

The natural rolling periods of these vessels under the loading conditions obtaining at the time of the observations were approximately as follows:

TABLE X.—ANALYSIS OF POWER LOSSES FOR S.S. MONTCALM, WHEN $\frac{\text{S.H.P.}}{\Delta} = 0.48$ APPROXIMATELY

Observation Number	S.H.P.	Speed, Knots	S.H.P. $\times 427.1$	Absorption of Power in Constant Notation				Ship Form $\frac{\Delta}{\text{E.H.P.} \times 427.1}$
				Shaft Friction	Propeller	Rudder	Wind and Waves	
33	0.485	15.38	1,548	0.077	0.481	0.036	0.193	0.761
30	0.472	15.21	1,550	0.078	0.477	0.016	0.219	0.760
29	0.482	15.0	1,655	0.080	0.497	0.040	0.279	0.759
24	0.471	14.91	1,660	0.082	0.520	0.032	0.268	0.758
25	0.475	14.88	1,690	0.083	0.534	0.040	0.275	0.758
23	0.478	14.8	1,720	0.085	0.544	0.040	0.293	0.758
28	0.478	14.76	1,730	0.085	0.564	0.012	0.311	0.758
8	0.479	13.5	2,210	0.110	1.840	0.024	0.504	0.732
7	0.483	12.9	2,560	0.128	1.011	0.040	0.660	0.721

TABLE XI.—ANALYSIS OF POWER LOSSES FOR S.S. SAN GERARDO, WHEN $\frac{\text{S.H.P.}}{\Delta} = 0.17$ APPROXIMATELY

Observation Number	S.H.P.	Speed, Knots	S.H.P. $\times 427.1$	Absorption of Power in Constant Notation				Ship Form $\frac{\Delta}{\text{E.H.P.} \times 427.1}$
				Shaft Friction	Propeller	Rudder	Wind and Waves	
70	0.174	10.91	1,466	0.073	0.658	0.032	0.033	0.67
64	0.160	10.30	1,709	0.085	0.841	0.032	0.091	0.66
31	0.178	9.37	2,300	0.115	1.148	0.038	0.349	0.65
32	0.176	9.08	2,508	0.125	1.276	0.057	0.400	0.65
42	0.180	8.79	2,826	0.141	1.405	0.044	0.586	0.65
23	0.161	8.09	3,280	0.164	1.782	0.022	0.662	0.65
29	0.166	8.05	3,410	0.170	1.766	0.016	0.808	0.65
36	0.173	8.07	3,515	0.176	1.861	0.038	0.790	0.65
27	0.169	7.90	3,680	0.184	1.952	0.032	0.862	0.65

<i>S.S. Montcalm</i>	17 seconds, approximately
<i>S.S. London Mariner</i>	9 seconds
<i>S.S. San Gerardo</i>	10 seconds
<i>S.S. San Tirso</i>	9 seconds

Maximum rolling angles of over 17 degrees were obtained on all these vessels, and the cycle of change from maximum angle through minimum to maximum angle again was most marked on every vessel.

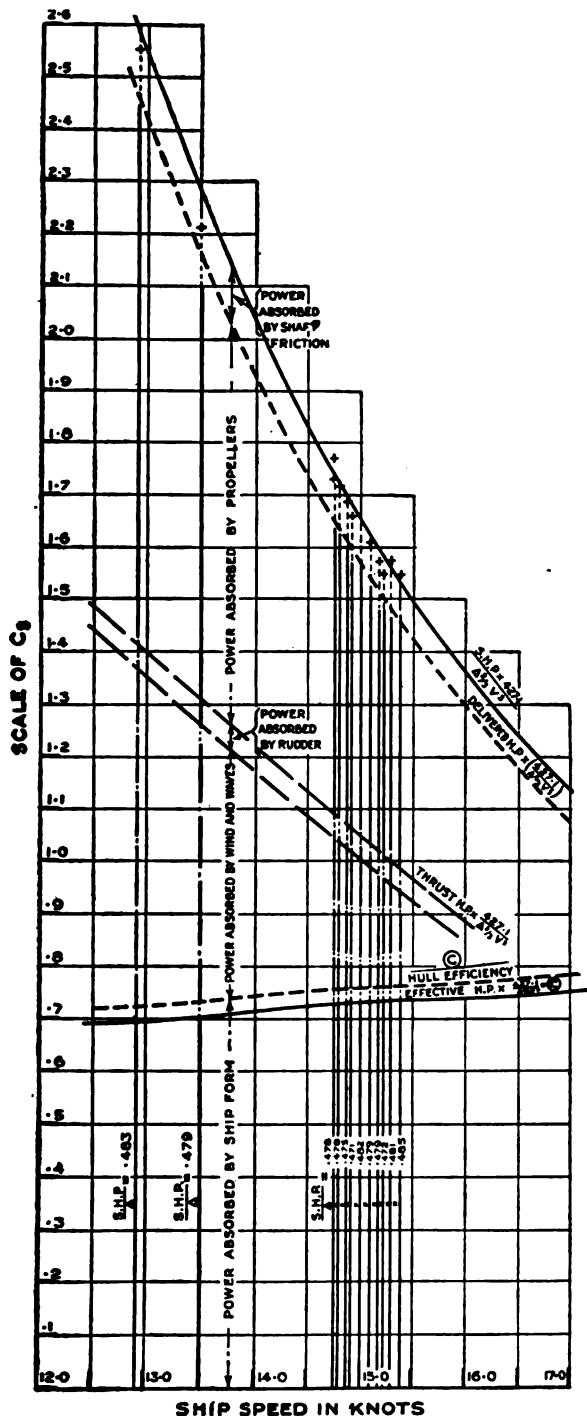


Fig. 3.—Analysis of Power Losses on S. S. Montcalm

From observations made during voyage in March, 1922. Approximate $\frac{\text{S.H.P.}}{\text{Displacement}} = 0.48$. Curves are drawn for ship with displacement of 20,120 tons and 9,660 shaft horsepower. S.H.P. is the power measured by the torsionmeter at the after side of the engine. D.H.P. is the power delivered to the propellers by the shafts at their after ends. T.H.P. is the power calculated from the thrust of the screws. E.H.P. is the power calculated from the form resistance (including shaft bossings and other appendages) and is derived from model experiment.

EFFECT OF WEATHER ON THE STEERING

The chief factors due to the weather, which tend to turn a ship from her course, are wind, waves, and (in a twin-screw ship) differences in the thrust between the port and starboard propellers.

Effect of Wind on Steering.—The degree to which the wind affects the steering of a ship depends upon the extent and longitudinal distribution of the vessel's upper works, as well as upon the direction and force of the wind. Vessels with one unbroken deck structure situated amidships (as in the *London Mariner*) will be less affected by the wind as regards steering than vessels with separate "islands" of deck erections of different heights with different lengths of gap between them, as in liners of the *Montcalm* type.

Effect of Waves on Steering.—As regards the waves, their direction relatively to the ship and their average height are the two chief factors affecting the steering.

Effect of Screws on Steering.—In a twin-screw ship any difference between the thrust of the port and starboard propellers will produce a turning moment on the ship which must be corrected by an increase in the rudder angle if the vessel is to keep her course.

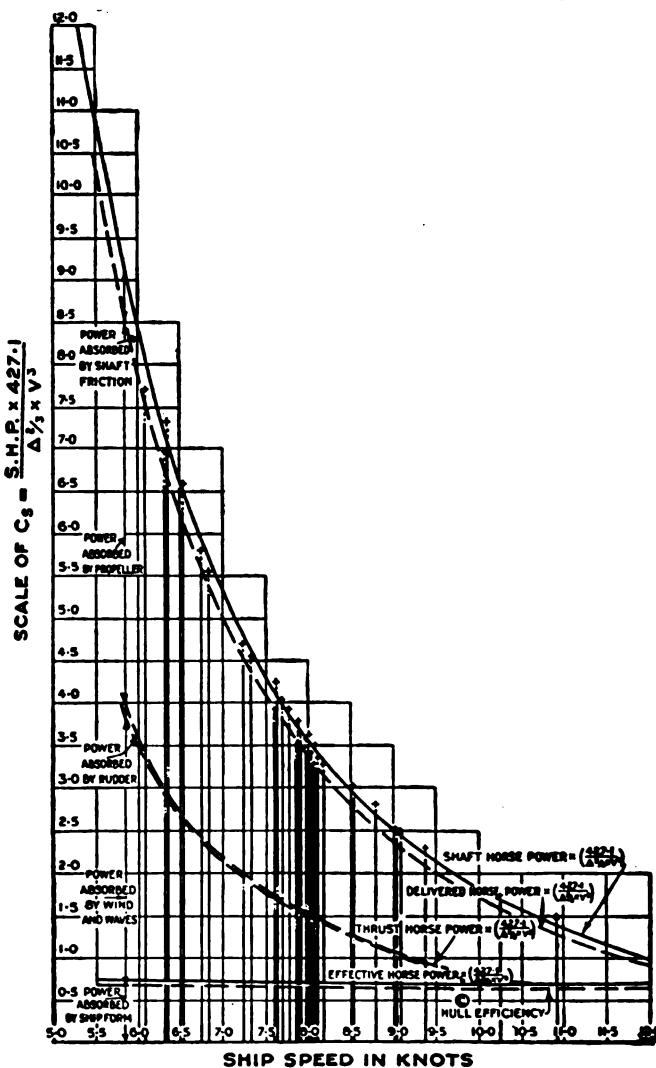


Fig. 4.—Analysis of Power Losses on S. S. San Gerardo

From observations made during voyage in March, 1923. Approximate $\frac{\text{S.H.P.}}{\text{Displacement}} = 0.17$. Curves are drawn for ship with displacement of 15,600 tons and 2,650 shaft horsepower. S.H.P. is the shaft horsepower measured by torsionmeter aft of the engine. D.H.P. is the power delivered to the propeller by the shaft. T.H.P. is the thrust horsepower calculated from the thrust of the screw. E.H.P. is the effective horsepower calculated from the form resistance and is derived from model experiment data.

In a single-screw ship it has been found by model experiments in smooth water that the screw exerts a turning moment on the ship in a direction depending upon the direction of rotation of the propeller. For a model of the ordinary cargo ship a rudder angle of about 2 degrees was required to keep the model on its course. Confirmation of this is given in Tables VIII and IX, which shows the rudder angle and direction necessary to keep the vessel on her course.

PRINCIPAL CAUSES PRODUCING LOSS OF SPEED IN SHIPS AT SEA

Any ship at sea meeting bad weather, experiences a reduction in speed for the same expenditure of power. This reduction in speed is due to four principal causes:

- (1) Increased resistance due to ocean waves.
- (2) Increased wind resistance on the ship's upper works.
- (3) Decrease in propeller thrust due to loss in propeller efficiency.
- (4) Increased resistance due to use of rudder.

Ocean Waves Resistance.—The extent to which the ship's resistance will be increased by the ocean waves it meets, depends principally upon the height of the waves and the period of encounter. Increased wave height almost invariably produces increased resistance if the ship is meeting the waves. In addition, if the ship's natural pitching period does not differ much from the period of encounter, large pitching angles occur, with increased ship resistance due to "slamming," and taking seas inboard, etc. If the ship is steaming through a following sea, the vessel's resistance will be lessened, the ship absorbing some of the wave energy, which will assist her progress, always provided the period of encounter between wave and ship, and the wave direction relative to ship, is such that minimum pitching and rolling result.

Wind Resistance.—The wind resistance on the ship's upper works will increase the ship's resistance roughly in proportion to the square of the increase in the apparent fore and aft wind speed; and the ship's resistance will be lessened by this amount if the wind is a following one.

Decrease in Propeller Efficiency.—The way in which the reduction in speed due to the weather usually produces a loss in propeller efficiency has already been discussed. This loss in propeller efficiency means increased waste of shaft horsepower, and consequently loss in thrust horsepower.

Rudder Resistance.—The increase in ship resistance caused by the rudder will be proportional to the amount of rudder angle used, and a further loss in thrust of the propeller will result from the use of the rudder.

The percentage loss of the total available shaft horsepower for which each of these causes was responsible can be roughly gaged from Fig. 3 and Table X, which gives the data obtained on the S.S. *Montcalm* on various dates, when

the $\frac{\text{Shaft Horsepower}}{\text{Displacement}} = 0.48$ approximately. The speed of

the ship varied from 15.4 knots to 12.9 knots; a loss of 2.5 knots. Shaft friction has been assumed to absorb 5 percent of the total shaft horsepower. The power dissipated by the propellers has been estimated by using the propeller efficiencies obtained from Froude's data, and that lost by the rudder has been calculated from the model experiment data. The effective horsepower was obtained by model experiment in smooth water, and the difference between the shaft horsepower observed and the sum of the powers absorbed in shaft friction, propeller, rudder and effective horsepower may be taken as the loss in power due to wind and waves. A similar analysis has been made for the *San Gerardo* (Table XI and

Fig. 4) for a $\frac{\text{Shaft-Horsepower}}{\Delta} = 0.17$ approximately.

From these tables it appears that the loss of power due to wind and waves increased from 12 percent to approximately 26 percent of the total power on the S.S. *Montcalm*, and from 2 percent to 31 percent in the *San Gerardo*.

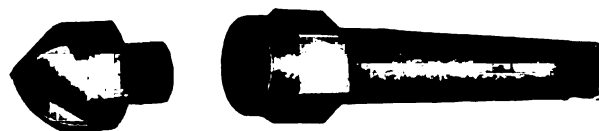
In order to obtain higher efficiency with the propeller at the greater slips inevitable in rough weather, it appears to be advisable to use smaller pitch propellers than are necessary to get the greatest efficiency under steam trial conditions. Care should be taken, however, to see that the reduced pitch does not cause the slip to fall too low in smooth water and fine weather, because of the very large drop in propeller efficiency which occurs at very low slips.

As regards rudder resistance and its effect on the propeller, in the absence of experiment data on the effect of wind, both on the resistance and turning moment exerted on deck structures, it can only be suggested that central deck erections produce the smallest need for rudder in high winds.

Two Piece Rivet Set and New Re-Cupping Tool

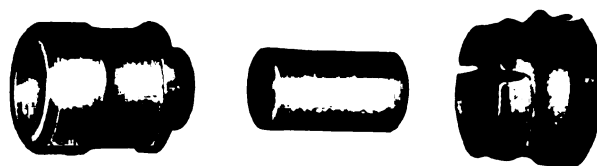
THE Lovejoy Tool Works, 313 West Ohio street, Chicago, is manufacturing two new tools known as the Mack re-cupping tool and the Mack universal two-piece rivet set for use in the yard and shop.

The re-cupping tool is intended for the reclamation of rivet sets of all shapes which have become battered and in



Mack Re-Cupping Tool for Rivet Sets

this condition cannot be of further service. With the new tool, rivet sets can be re-cupped without annealing or other heat treating process. The re-cupping tool, which is made of a special tungsten steel and of a form developed after years of experimental work, will re-shape the cup of a rivet set even though it is quite hard. This tool is made in two parts,



Mack Two-Piece Rivet Set

the heads being removable and interchangeable, with a standard No. 3 Morse taper shank so that different size heads can be used with a single shank.

The re-cupping operation is accomplished by placing the rivet set in the chuck of a lathe and the re-cupping tool in the tail stock.

UNIVERSAL TWO-PIECE RIVET SET

In attempting to lengthen the life of rivet sets, the new Mack universal set has been made in two pieces which are held together with a special spring steel clip. The only wear takes place on the head of the rivet set, the shank being practically a second plunger. These tools are made from special vanadium steel and, as stated by the company, will be supplied for trial on request. The special two-piece clip fits all standard pneumatic hammers.

Practical Diesel Engineering—III

Mechanical Cycles—Construction of Two and Four Cycle Engines—Opposed Piston and Double Acting Engines

By Louis R. Ford*

THE cycles that have been discussed are descriptive of heat processes that may be carried out by various arrangements of mechanism, and may be called heat cycles. The terms 4-cycle and 2-cycle, that are a part of everyday engine room language, have a more practical meaning and, since they designate the particular mechanical arrangements used for executing the heat processes that are carried out in the engine, they may be called "mechanical cycles." It has been stated that the two heat cycles in universal use in oil engine construction and operation are the Otto and the Diesel. Any internal combustion engine, regardless of whether it operates on the Otto or Diesel principle, is said to have a four stroke cycle or a two stroke cycle, according to whether it receives a working impulse on the piston every other revolution or every revolution. These two terms are commonly abbreviated to 4-cycle and 2-cycle, and engines of either type may be single acting or double acting.

THE 4-CYCLE ENGINE

Fig. 8 shows the elements of a 4-cycle, single acting, Diesel engine, including the accessories needed to make it run. These necessary auxiliaries may be grouped into many different arrangements in relation to the engine structure, but are here shown in positions convenient for sketching. The piston is shown just starting a downward, suction stroke. The air inlet valve *A* is open and air is being drawn into the cylinder through the air inlet pipe *B*. The exhaust valve *C*, fuel valve *D* and air starting valve *E* are all closed. As the piston reaches the end of the suction stroke the air inlet valve closes and as the piston rises on the second, or compression, stroke the air in the cylinder is compressed. At the end of this stroke the air has been compressed to about 450 pounds and, as a result of this compression, its temperature has risen to about 1,000 degrees F. The fuel injection valve *D* now opens, and the oil that has been pumped into the valve by the fuel pump *F* is sprayed into the cylinder by air drawn from the supply stored in the spray air bottle *G*, at about 900 pounds pressure. The high temperature of the compressed air in the cylinder ignites the fuel, and it continues to burn as long as injection is maintained. This burning raises the temperature of the gas to approximately 3,000 degrees F. In the meantime the piston has started down on the third, or expansion, stroke with the gas expanding behind it. The injection valve closes shortly after the piston has started down on this stroke. At the end of this stroke the exhaust valve *C* opens and the burned gases in the cylinder, now reduced to about 40 pounds pressure, and correspondingly reduced in temperature, start to flow out through the exhaust pipe *H*. Returning on the fourth, or exhaust, stroke the piston pushes the remaining gas out of the cylinder. At the end of this stroke the exhaust valve closes, the air inlet valve opens and the cycle of operations starts again. It is thus seen that one complete cycle requires four strokes of the piston, hence the term "4-cycle." These four strokes comprise two complete revolutions of the crank and a turning impulse, from the expanding gas, is received once every two revolutions.

The fuel pump *F* is a simple, single acting, plunger pump, very accurately finished in order to be able to handle minute quantities of oil per stroke at high pressure, and receives its motion from the main crankshaft or the camshaft, through gearing or some sort of linkage. It makes a stroke at each revolution of the crankshaft. In the 4-cycle engine, since

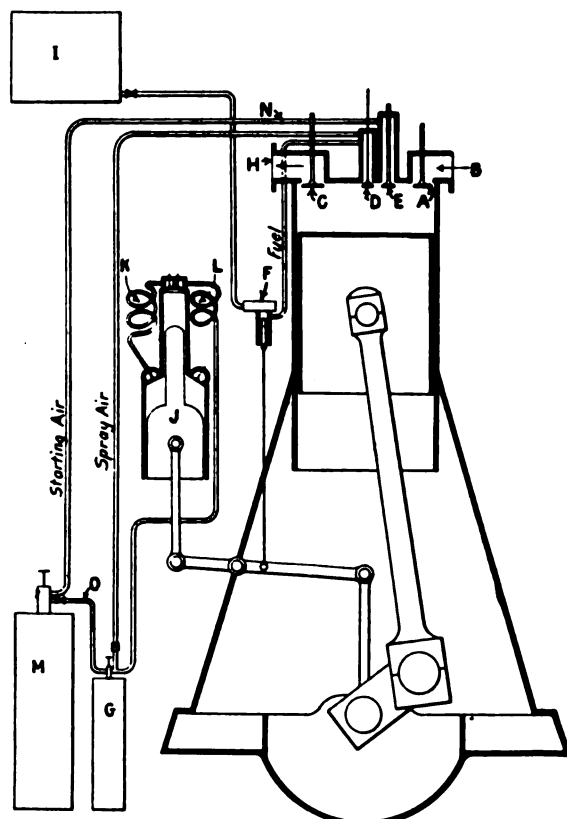


Fig. 8.—Elements of a 4-Cycle Engine

fuel injection occurs only every other revolution, this means that the fuel pump at each stroke discharges only half of the amount of oil required for each injection. The usual custom is to provide a separate pump for each power cylinder, but on some engines only one pump is used, supplying oil to all of the cylinders through a discharge pipe which has a branch to each cylinder. Oil flows by gravity into the suction side of the pumps from an elevated supply tank *I*. The pressure on the discharge side of the pump depends on the spray air pressure. The oil is not pumped directly into the cylinder but is discharged into the interior of the injection valve body. Since this valve body, or chamber, is at all times filled with spray air at full pressure the oil discharge pressure from the pump must be high enough to overcome this air pressure. The oil discharge is delivered into the valve chamber while the injection valve, or spray valve as it is commonly called by American engineers, is closed and lies in the bottom of the valve chamber until the valve opens. When this occurs the high pressure spray air blows it into the cylinder, at the same time breaking it up into a fine mist.

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The source of high pressure air for this spraying of fuel into the cylinders is the air compressor *J*. It is usually operated directly from an additional crank on the main crank shaft, but in some designs it is mounted behind the engine and operated by walking beams connected to the crosshead or connecting rod. The compressor is built to compress air in two, three or four stages, the three stage

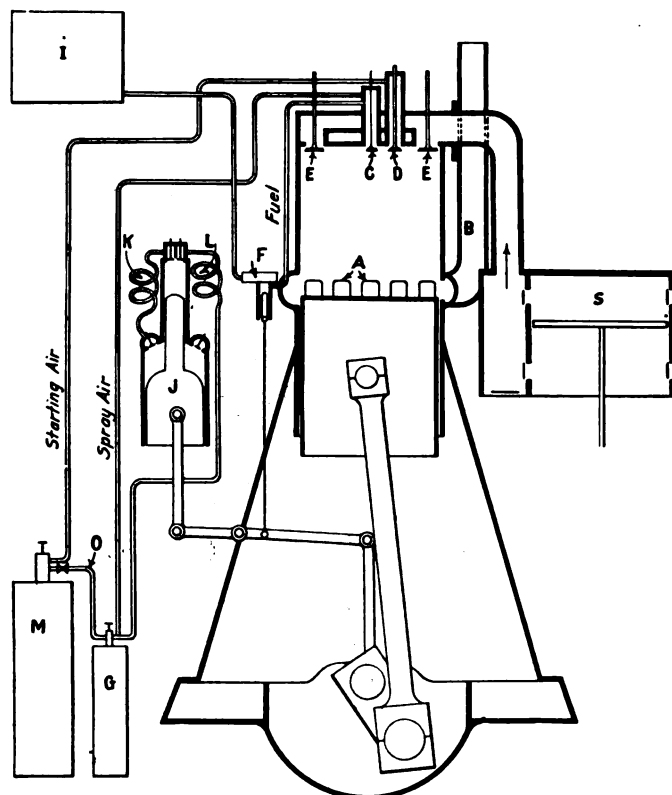


Fig. 9.—Elements of a 2-Cycle Engine

construction being that generally used. A cooling coil, *K* and *L*, is used to cool the air after each stage of compression. The air, instead of going direct to the spray valves, is stored in the spray bottle *G* so that a small reserve is always on hand to be used when the engine is started and to prevent fluctuations in pressure while running. The engine must be given an initial impulse when starting, so that it will begin to turn and start its own combustion. This is done with compressed air at about 350 pounds pressure, stored in the air tank *M*. This tank is always kept full, and when the starting gear is thrown into action the air flows from the tank through pipe *N* to the starting valve *E*. The starting gear opens and closes this valve in such a way as to cause the engine to operate on air just as a steam engine operates on steam. As soon as combustion of fuel occurs in the cylinder and the engine begins to operate under its own power the starting gear is thrown out of action and the starting valve remains closed. When the air stored in the starting air tank is depleted by starting the engine it is replenished by by-passing some of the air from the spray air compressor through pipe *O*. The details of the mechanism for performing the various operations described will be discussed later.

THE TWO-CYCLE ENGINE

The elements of a 2-cycle, single acting, Diesel engine are shown in Fig. 9. Most of the accessory equipment is the same as that shown for the 4-cycle type, but, instead of an exhaust valve, it is seen that there is a ring of exhaust ports *A* around the bottom of the cylinder, communicating with the exhaust pipe *B*. The spray valve *C* and starting

valve *D* are the same as in the 4-cycle. In place of the air inlet and exhaust valves there are two scavenging valves *E*. These scavenging valves are in communication with a passage leading to a low pressure scavenging air compressor *S*, operated from the engine in a manner similar to the spray air compressor. When the piston on its downward stroke uncovers the exhaust ports the scavenging valves open and the air, at 2 to 10 pounds pressure, flows into the cylinder and pushes the exhaust gases out through these ports. As the piston on its up stroke covers the exhaust ports the scavenging valves close, leaving the cylinder full of fresh air. The piston, moving upward on its compression stroke, compresses this air and at the end of compression fuel injection occurs, just as previously described for the 4-cycle. It is thus seen that the complete series of operations, including fuel injection and combustion, expansion, exhaust, filling cylinder with fresh air and compression, occurs in two strokes of the piston, or one revolution of the crank shaft—hence the name "2-cycle." The crank receives a turning impulse once every revolution.

A variation from the scavenging arrangement just described, used with some designs of 2-cycle engines, is shown

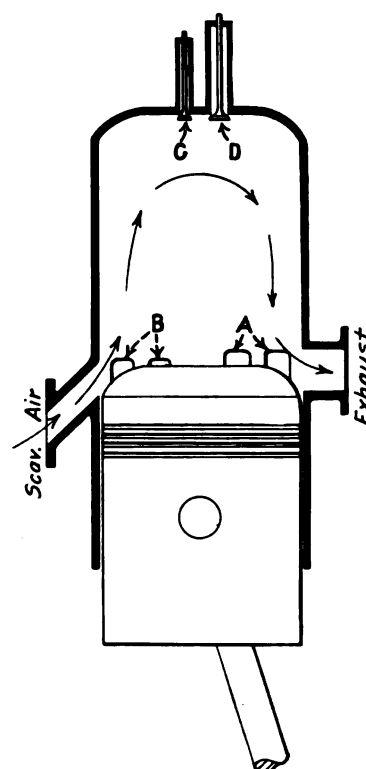


Fig. 10.—Two-Cycle Cylinder With Port Scavenging

in Fig. 10. The exhaust ports *A* are placed in one side of the cylinder and on the opposite side are scavenging ports *B*. The exhaust ports are slightly higher than the scavenging ports so that the piston uncovers the exhaust ports first, thus allowing the pressure in the cylinder to fall before the scavenging ports are opened. By the time the scavenging ports are uncovered the pressure in the cylinder has fallen to atmosphere and the scavenging air rushes in. By inclining the scavenging ports and shaping the piston head, the entering air is deflected upward, as shown by the arrows, and sweeps the burned gases out of the upper part of the cylinder and out through the exhaust ports. When the piston covers the ports on its up stroke the air is trapped in the cylinder and is then compressed. This arrangement of scavenging does away with the necessity for the two scavenging valves in the cylinder head. The only cylinder head

valves then required are the spray valve *C* and starting air valve *D*. This simplifies the head, makes it easier to cast, makes cooling easier and reduces the liability to crack. It has the disadvantage, however, of not clearing out the burned gases as thoroughly as the valve-in-head scavenging arrangement.

FOUR-CYCLE AND TWO-CYCLE ENGINES COMPARED

Theoretically the 2-cycle should have a two to one advantage over the 4-cycle engine. It receives a power impulse every revolution, as against the power impulse every other revolution of the 4-cycle. Since the power for driving the engine during the time when there is no expanding gas exerting driving force on the piston must come from the flywheel, the longer interval between the power impulses of the 4-cycle necessitates a much heavier flywheel. For equal power the 2-cycle cylinder should be half the size of the 4-cycle and the dimensions and weights of the rest of the engine should be correspondingly less. In actual practice, however, this two to one advantage does not exist. A very large scavenging compressor is needed for the 2-cycle to clear out the burned gases and fill the cylinder with pure air needed for the combustion of the fuel. Unless the volume of scavenging air is greater than the power cylinder volume the mean pressure that can be obtained in the power cylinder will be very low. The ratio of these volumes is usually about 1.5 to 1. The operation of this compressor uses up considerable power and adds weight to the engine. Scavenging is never perfect, so the cylinder is never completely filled with pure air. Combustion in the 2-cycle occurs twice as often as in the 4-cycle, consequently the heat must be taken out more rapidly. This means that the mean pressure can not be carried as high. A further 2-cycle disadvantage is that the exhaust ports must be uncovered before the piston reaches the end of its stroke in order to give the gases time to get out of the cylinder. This means that exhaust begins at a higher pressure in the 2-cycle than in the 4-cycle and results in extra loss of heat. The net result of the effect of all the factors that influence comparative dimensions is that according to present practice, for cylinders of equal power with equal revolutions, the 2-cycle engine requires about 25 percent smaller diameter than the 4-cycle.

The situation, as it exists at the present, is that the 4-cycle engine is more generally preferred, except in the small sizes, because, as a whole, it has given less trouble in service, but as the power per cylinder increases a limit is reached with the 4-cycle beyond which the cylinder diameter can not be increased and the 2-cycle system must be used. There are some designs of 2-cycle engines that have been consistently successful in all sizes. Owing to improvements in design and in the materials and methods of construction the use of the 2-cycle engine is steadily increasing.

THE OPPOSED PISTON ENGINE

It will be noted from the preceding descriptions that the pressure of the expanding gas is applied on only one side of the piston. This has always placed a heavy handicap on the Diesel engine in the matter of weight, size and cost in competing with the steam engine. As a consequence a great deal of study has been devoted to the designing of a satisfactory double acting Diesel engine. The principal difficulty with such an engine has been the necessity for a piston rod. Since this rod, which must operate in flaming gas having a maximum temperature of 3,000 degrees F., or more, can not be easily cooled and must pass through a stuffing box that must be packed against 450 to 500 pounds pressure, it is evident that the problem is not a simple one. Numerous other difficulties, such as complication of the bottom cylinder head, cylinder cooling troubles, etc., have contributed toward making the successful double acting design difficult of attainment. The use of what is known as "op-

posed pistons" resulted in the production of some of the double acting effects while retaining single acting construction and thus side stepping some of the single acting difficulties just mentioned.

Fig. 11 illustrates the principle of the opposed piston engine. The cylinder *A* is simply a long barrel, open at both ends, and contains two pistons *B* and *C*. The lower piston is connected to the crank shaft in the usual way. The upper piston is connected to the crank shaft through the yoke *D*, rods *E* and the two cranks *F*. In the upper end of the

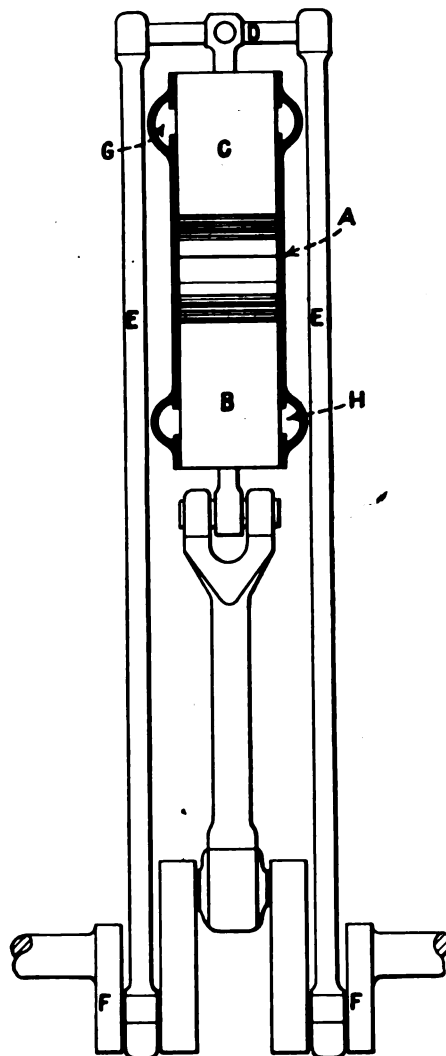


Fig. 11.—Opposed Piston Engine

cylinder is a ring of exhaust ports *G*, and in the lower end a ring of scavenging ports *H*. The two pistons move inward and outward together. When their movement brings them to their point of closest approach, in the middle of the cylinder, the air is compressed between them. Fuel is injected into the center of the cylinder, between the two pistons, and when combustion occurs they are driven away from each other, toward the ends of the cylinder. At the end of the stroke the upper piston uncovers the exhaust ports and the lower piston uncovers the scavenging ports, so that the scavenging air sweeps upward through the entire cylinder length and pushes out the burned gases. During the power stroke the lower piston pushes downward on its crank while the upper one pulls upward on its two cranks. One of the serious objections to this design is the necessity for three cranks for each cylinder. This makes a very complicated and expensive crank shaft.

A variation in opposed piston construction, designed to

do away with the two extra cranks under each cylinder, is shown in Fig. 12. Two cylinders, *A* and *B*, are combined in a single unit. The two lower pistons, *C* and *D*, are connected to their cranks in the usual way through piston rods, crossheads and connecting rods. The upper pistons, *E* and *F*, are provided with crossheads, *G* and *H*. Upper crosshead *H* is connected by an oblique rod to lower crosshead *I*,

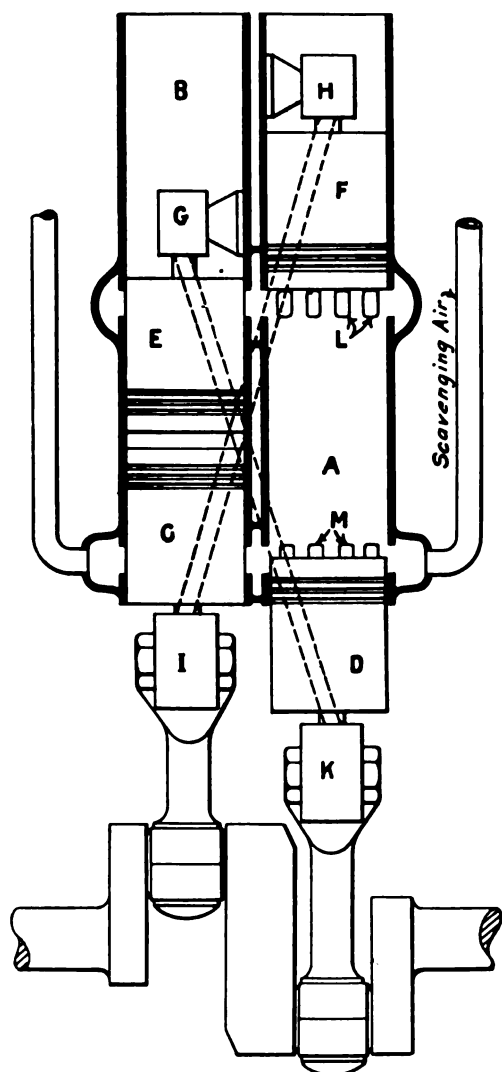


Fig. 12.—Opposed Piston Engine Using One Crank Per Cylinder

and upper crosshead *G* is similarly connected to lower crosshead *K*. One pair of pistons moves outward while the other pair moves inward. When pistons *C* and *E* start away from each other, *C* pushes downward on its crank while *E* pulls upward on the other crank. On the next stroke, pistons *D* and *F* act in the same way on the same two cranks. Scavenging of the burned gases is carried out in the same way as that previously described for the opposed piston type. The exhaust ports *L* are located at the top of the cylinder and the scavenging ports *M* at the bottom.

THE DOUBLE ACTING ENGINE

The two opposed piston types described have apparently proven successful in practice and are being installed in a number of large vessels. They have a number of advantages but can not be considered as the last word in Diesel design. At best they only serve to bridge the gap between the single piston, single acting type and the double acting. Development of the latter type is actively in progress, and the

design is being worked out along different lines by different engine builders. This development has proceeded far enough with one design so that several large passenger liners are being equipped with engines of the double acting type. Since the double acting principle is the only answer to the demand for increasingly higher power per cylinder it is probable that most marine Diesel engineers of the present day will

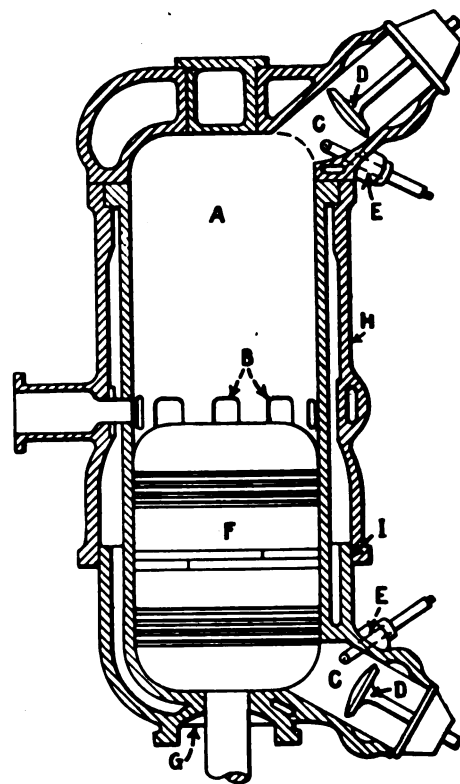


Fig. 13.—Cylinder of Double Acting Diesel Engine

be called upon eventually to operate double acting Diesel engines.

Fig. 13 shows the cylinder of a recently designed double acting, two-cycle engine that will serve to illustrate the action of the double acting principle. The cylinder *A* is arranged with a belt of exhaust ports *B* in the center, and a combustion chamber *C* at each end. In an extension of each combustion chamber is a scavenging air valve *D*. A spray valve *E* is arranged to inject fuel into each combustion chamber. The piston *F* is made long enough to fill approximately half of the cylinder, and is provided with two sets of rings. It is shaped to conform to the shape of the cylinder ends, these ends being rounded for strength. The piston is made in halves, joined at the center. It will be noted that there is no separate bottom head, the cylinder liner and bottom head being cast in one piece, with the piston rod stuffing box *G* in the center. The water jacket *H* is cast separate and provides an expansion joint at *I* so that the liner is free to expand. The action of the engine is obvious from the sketch. The piston travels far enough on each stroke to place the exhaust ports in communication alternately with the top and bottom ends of the cylinder. The series of events occurring in each end of the cylinder is the same as that occurring in the top end of the single acting, valve scavenging, 2-cycle engine previously described. The starting valve has been omitted for the sake of clearness. It is usually placed in the top head. In order to make the casting as simple as possible no starting valve is used in the bottom end.

(To be continued)

Water Rates and Steam Consumption of Auxiliaries-III*

Steam Used by Air Pump and Ejector, Condensate, Bilge and Lubricating Oil Pumps—Summation of First Group

By E. A. Stevens, Jr.,† and H. E. Brelsford‡

THERE are two main classes of air pumps, the attached and the independent. Attached air pumps are found on most cargo ships, tankers and some passenger ships fitted with reciprocating engines. Independent air pumps are found on practically all turbine driven vessels, where an air pump is used, and on some passenger and a few cargo ships fitted with reciprocating engines.

When the attached air pump is used, no calculations need be made, as the power required is very small, being about 1/4 percent or less of the power of the main engine.

When the air pump is independent, it is required to produce either the whole vacuum or only part of it, the rest being taken care of by a vacuum augmenter. As the mechanical efficiency of this pump varies considerably with the vacuum, the ratio of air to water pumped and the temperature of the air, and as very little has been published about this subject, no rule or curves can be given. From what data there are at hand, it would seem that the following formula will give fairly close results:

MAIN AIR PUMP

$$\text{I.H.P. of air pump} = \frac{Wc}{C} + 1$$

Wc = weight of steam condensed in pounds per hour.

C = constant, as follows:

Vacuum	C	Vacuum	C
24	13,680	27	8,640
25	12,000	28	6,960
26	10,320	28 1/4	6,540

Steam consumed in pounds per hour = I.H.P. × W.R.

W.R. = water rate from Fig. 7.

The vacuums given are at the air pump suction, which, in well designed outfits, are generally from 0.15 inch to 0.2 inch higher than at the turbine exhaust.

When calculating the I.H.P. of the air pump, when an augmenter is used, take the vacuum at the air pump suction as 4 inches less than the vacuum at the dry air outlet of the condenser.

EXAMPLE

Steam condensed in one condenser = 71,165 pounds per hour.

Vacuum at turbine exhaust = 28 inches.

Vacuum at air pump suction = 28.2 inches.

Stroke of air pump = 21 inches.

Find steam required, if an air pump only is used, and the steam required by the air pump, if a vacuum augmenter is also used.

When no augmenter is used, C = 6,624.

$$\text{I.H.P. of one air pump} = \frac{71,165}{6,624} + 1 = 11.74.$$

Water rate from Fig. 7 = 137 pounds.

Steam consumed per hour for both pumps = $2 \times 11.74 \times 137 = 3,126$ pounds.

When an augmenter is used, vacuum at air pump suction = 24.2 inches and C = 13,344.

$$\text{I.H.P. of one air pump} = \frac{71,165}{13,344} + 1 = 6.33.$$

Water rate from Fig. 7 = 137 pounds.

Steam consumed per hour for both pumps = $2 \times 6.33 \times 137 = 1,735$ pounds.

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†Department of Maintenance and Repair, United States Shipping Board, Emergency Fleet Corporation, New York, and member of Fuel Conservation Committee, U. S. Shipping Board.

‡Chief of Technical Section, Department of Maintenance and Repair, United States Shipping Board, Emergency Fleet Corporation, New York.

To this will have to be added the steam used by the vacuum augmenter, which will be taken up later.

AIR EJECTOR AND VACUUM AUGMENTER

In order to estimate the steam required for the air ejector or vacuum augmenter, it is necessary to know the amount of air to be removed and its temperature.

In the twenty-seventh Transactions of the Society of Naval Architects and Marine Engineers there is a paper by G. L. Kothny on "New Developments in High Vacuum Apparatus" in which he states, "No rule can be laid down for the

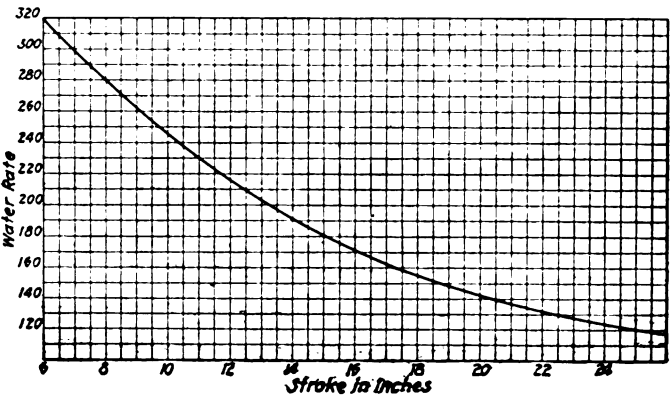


Fig. 7.—Water Rate of Air Pumps

$$\text{Indicated horsepower of air pump} = \frac{W}{C} + 1.$$

W = steam condensed in pounds per hour.

Vacuum	C
24	13,680
25	12,000
26	10,320
27	8,640
28	6,960
28 1/4	6,540

amount of air leakage, as it depends on the size and character of the installation." And, "Extensive investigations have shown that the normal air leakage for marine surface condenser installations can be limited to the amount shown in Plate 68, provided that the auxiliaries exhausting into the main condenser do so at a pressure slightly above atmosphere. The curve illustrated in Plate 68 is based on the total amount of steam which the condenser receives. It also includes the air contained in the exhaust steam."

The amount of air entering the condenser, as shown by the curves on the above mentioned plate, can be obtained from the following formulas:

Turbine installations, $W_a = (0.00025 \times W_c) + 7.5$

Reciprocating engine installations $W_a = (0.000575 \times W_c) + 22.5.$

W_a = weight of air entering condenser in pounds per hour.

W_c = weight of steam condensed in condenser in pounds per hour.

Very little is known about the temperature of the air at the suction of the air ejector or vacuum augmenter but it would appear from tests made by Joseph B. Lincoln and O. A. Van Denburg, Jr., on the main condensers of U. S. S. *Tennessee* and *Maryland*, which was published in the *Journal of the American Society of Naval Engineers*, Vol. XXXIV,

No. 4, that, when the dry air suction is so placed that the air is required to pass around a baffle before leaving the condenser, its temperature will not be more than 5 degrees F. higher than the temperature of the overboard discharge, when the condenser is being operated at full capacity.

The temperature of the air suction from the condenser on the *Tennessee*, which is of the Lovekin type, was the same as the overboard discharge, while the temperature of the air suction of the *Maryland's* condenser, which is of the Navy type (being circular in section), was 2.6 degrees F. higher. If, however, the air is withdrawn from the bottom of the condenser as was the practice in the early turbine installations, where a vacuum augmenter was used, its temperature would be practically equal to that of the steam at the existing vacuum.

From the data contained in an article on the "Radojet Air Pump" by M. C. Stuart and A. H. Senner, published in the *Journal of the American Society of Naval Engineers*, Vol. XXXII, No. 3, the amounts of steam required to remove one pound of air at various vacuums and temperatures were computed, from which the curves on Fig. 8 were drawn.

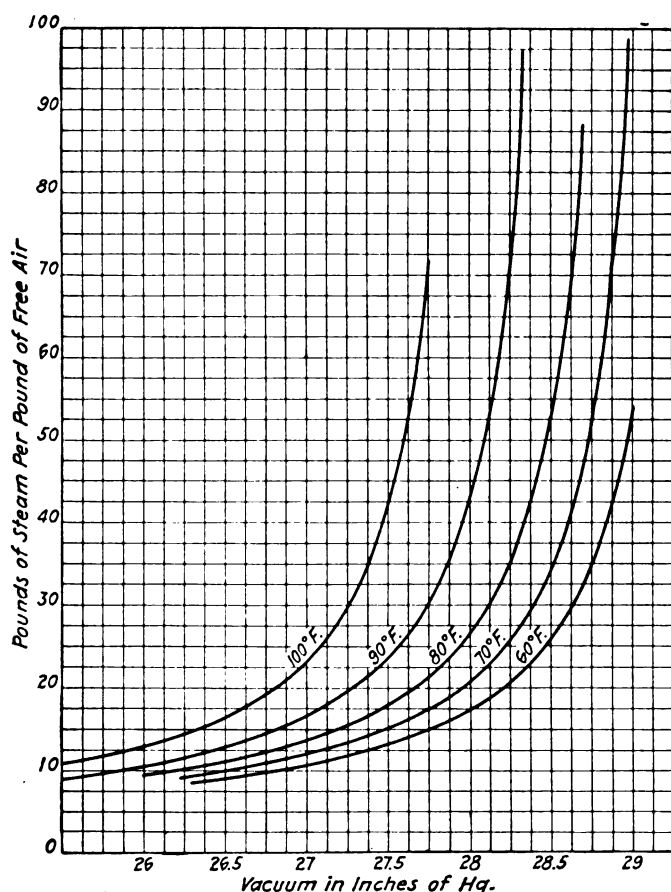


Fig. 8.—Steam Consumption of Air Ejectors

If an intercondenser is fitted, the steam used will be 50 percent of that shown on these curves.

The required steam, as given by these curves, will handle not only the air but whatever water vapor there may be with it, at the given vacuum and temperature. If an intercondenser is fitted, the steam required will be about 50 percent of that shown, while a vacuum augmenter will require about 10 percent.

EXAMPLE

Find the amount of steam required by an air ejector without and with an inter-condenser, and a vacuum augmenter. Steam condensed in each instance = 71,165 pounds per hour. Vacuum at turbine exhaust = 28 inches, then vacuum at dry air suction = 28.2 inches. Air entering each condenser in pounds per hour = $(0.00025 \times 71,165) + 7.5 = 25.29$.

From the example under "Circulating Pump," we find that the overboard discharge is 80 degrees F., then take temperature of dry air suction = 85 degrees F.

From Fig. 8 we find that it requires 43 pounds of steam to remove 1 pound of air, then the steam consumption of the air ejectors of one condenser will be $25.29 \times 43 = 1,087$ pounds per hour and for both condensers will be $2 \times 1,087 = 2,174$ pounds.

If an intercondenser was used, the steam required for both condensers would have been 1,087 pounds per hour.

If vacuum augmenters with an air pump were used in place of air ejectors, the steam used per hour by the augmenters for both condensers would have been 217 pounds.

CONDENSATE PUMPS

There are two types of condensate pumps in general use, the centrifugal and the direct acting reciprocating pump.

The centrifugal pump is generally driven by a direct connected turbine although an electric motor has been used in a few cases. It could be driven by a geared turbine or a reciprocating engine, although no such arrangements, that the writer knows of, exist. The discharge head, including friction, will be about double the height of the water in the feed and filter tank above the pump, which is, as a rule, about 5 feet, making a total discharge head, including friction, of 10 feet. The suction head will be negative as the pressure in the condenser is less than that of the atmosphere. If the suction head in feet is taken equal to the vacuum in inches, the result will be close enough for this work. The total head in feet can then be taken equal to the vacuum in inches plus ten.

If a direct acting reciprocating pump is used, it is necessary to have some arrangement to insure that the water seal between the pump and condenser exists. In order to do this, there is generally a reservoir directly below the condenser in which a float regulates the speed of the pumps. The level of the water is, as a rule, about 4 to 6 feet above the water cylinder of the pump, which reduces the negative head due to the vacuum in the condenser. To offset this, the resistance of the pump suction and discharge valves has to be taken into consideration, which amounts to about 6 pounds per square inch or about 14 feet. The discharge head, including friction, will be the same as that of the centrifugal condensate pump, namely, 10 feet. The total head will then be equal to the vacuum in inches plus twenty.

The water H.P. will be

$$\text{Water H.P.} = \frac{Wc \times H}{33,000}$$

Wc = steam condensed in condenser in pounds per minute.

H = total head in feet = vacuum in inches + K.

K = 10 for centrifugal pumps and 20 for reciprocating pumps.

The efficiency of centrifugal condensate pumps is about 0.40, then

$$\text{S.H.P.} = \frac{\text{Water H.P.}}{0.40}$$

The water rates are obtained from Fig. 5 in the same manner as explained under "Forced and Induced Draft Blowers."

Steam consumption in pounds per hour = S.H.P. $\times$ W.R.

W.R. = water rate from Fig. 5.

C = 1.15 for reciprocating engine.

C = 1.3 for turbines.

If a direct acting reciprocating pump is used, the mechanical efficiency and water rates are obtained from Fig. 9.

$$\text{I.H.P.} = \frac{\text{Water H.P.}}{\text{M.E.}}$$

Steam consumption = I.H.P. $\times$ W.R.

M. E. = mechanical efficiency from Fig. 9.

W. R. = water rate from Fig. 9.

EXAMPLE

Find the steam required to operate the condensate pumps (a) centrifugal pumps driven by direct connected turbines and (b) direct acting reciprocating pumps.

(a) Centrifugal pumps—

Steam condensed in each condenser = 1,186 pounds *per minute*.
Vacuum = 28 inches. Then total head = 28 + 10 = 38 feet.

$$\text{Water horsepower} = \frac{1,186 \times 38}{33,000} = 1.37.$$

$$\text{S.H.P.} = \frac{1.37}{0.40} = 3.4.$$

Water rate from Fig. 5 (for S.H.P. = 3.4) = 108.5 pounds.

Corrected water rate = 108.5 × 1.3 = 141 pounds.

Steam consumption in pounds per hour for one condensate pump = 3.4 × 141 = 480 pounds.

Steam consumed by both condensate pumps = 2 × 480 = 960 pounds.

(b) Direct acting reciprocating pump, 12-inch stroke. Steam condensed in each condenser = 1,186 pounds *per minute*. Vacuum = 28 inches. Then total head = 28 + 20 = 48 feet. Water

$$\text{horsepower} = \frac{1,186 \times 48}{33,000} = 1.73.$$

Mechanical efficiency from Fig. 9 = 0.773.

$$\text{I.H.P.} = \frac{1.73}{0.773} = 2.24.$$

Water rate from Fig. 9 = 170 pounds.

Steam consumption in pounds per hour for one condensate pump = 2.24 × 170 = 381 pounds.

Steam consumed by both condensate pumps = 2 × 381 = 762 pounds.

ENGINE AND FIRE ROOM BILGE PUMP

The amount of water pumped from the bilges varies considerably and the only way to determine it is from the double strokes of the bilge pump, which is not very satisfactory as the slip is considerable, being probably as high as 35 to 45 percent. In estimating the steam consumption of this pump for new work or in cases where the double strokes are not known, the water pumped per minute may be estimated by the following formula:

$$\text{Water pumped, pounds per minute} = (0.2 \times \text{H.P.}) + 200.$$

H.P. = total I.H.P. or S.H.P. of all shafts.

As the bilges are on practically the same level as the keel, the total static head includes the suction and discharge and will be approximately equal to the draft of the ship, if the discharge is below the water line. When the discharge is above the water line, the total static head will equal the height of the discharge above the base line. The friction head for a given ship will depend upon the amount of water pumped in a given time, but a fair average would be about 60 percent of the static head, so in most cases the total head may be taken at 1.6 actual mean draft when the discharge is below the water line. When it is above the water line the total head should be taken as 60 percent greater than the height of the discharge above the base line.

The steam consumption is estimated in the same manner

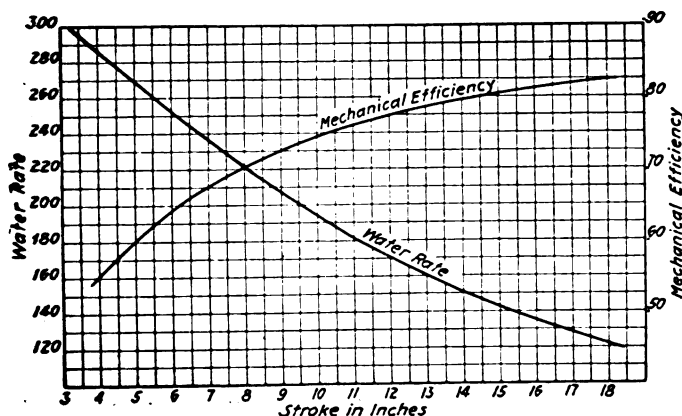


Fig. 9.—Water Rate and Mechanical Efficiency of Sanitary, Lubricating Oil, Lubricating Oil Cooler and Reciprocating Condensate Pumps

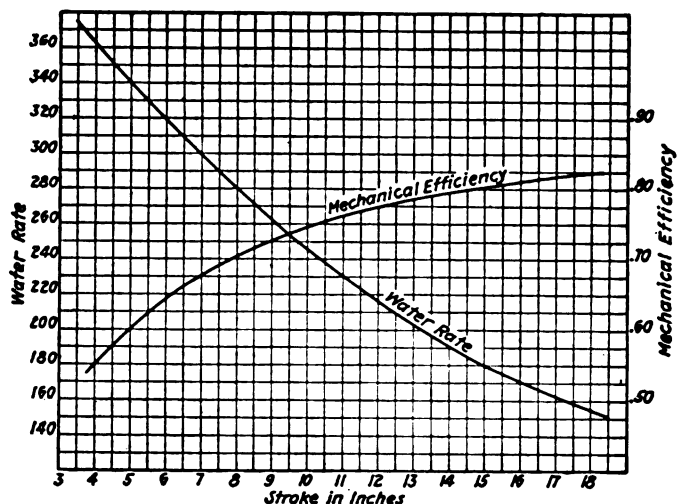


Fig. 10.—Water Rate and Mechanical Efficiency of Bilge Pumps

as explained under "Feed Pumps" except that the mechanical efficiencies and water rates are taken from Fig. 10.

EXAMPLE

Draft of ship, 30 feet. Discharge, 2 feet above load water line. Stroke of bilge pump = 12 inches.

Find the water pumped and steam consumption.

Water pumped = $W = (0.2 \times 12,000) + 200 = 2,600$ pounds *per minute*.

Total head = $1.6 \times 32 = 51.2$ feet.

$$\text{Water H.P.} = \frac{2,600 \times 51.2}{33,000} = 4.04.$$

Mechanical efficiency from Fig. 10 = 0.773.

I.H.P. = $4.04 \div 0.773 = 5.23$.

Water rate from Fig. 10 = 215.

Steam consumption = $5.23 \times 215 = 1,124$ pounds per hour.

LUBRICATING OIL PUMP

The approximate amount of lubricating oil required for geared turbines may be found by the following formula:

$$G = [(0.025 \times \text{S.H.P.}) + 100] \times C.$$

G = U. S. gallons per minute for each unit.

S.H.P. = shaft horsepower per shaft.

C = constant, as follows:

Double reduction gears and single turbine, where the high speed pinion drives two high speed gears which are connected to two low speed pinions driving a single low speed gear, $C = 1$.

Double reduction gears and single turbine, the high speed pinion driving one high speed gear, $C = 0.65$.

Double reduction gears and cross compound turbine, $C = 1$.

Single reduction gear and cross compound turbines, $C = 0.75$.

Single reduction gear and single turbine, $C = 0.45$.

From Table 1 (see page 427 of the July issue) we find that the weight of lubricating oil is 7.72 pounds per U. S. gallon, so the weight will be $7.72 \times G$.

If a gravity system is used, the amount of oil pumped will be from 20 to 50 percent greater, as it is customary to have the oil in the gravity tank overflowing. In the overflow pipe is a sight gage so that the engineer can assure himself that there is nothing wrong with the system. The pressure at the pump discharge in this system is, as a rule, from 20 to 25 pounds per square inch. In the pressure system the amount of oil pumped can be taken as given by the above formula and the pressure at the pump discharge taken at 15 to 20 pounds per square inch. As a rule, the pump cylinders are placed as low as possible so the suction head will be very small. The total head may, as a rule, be taken at about 10 pounds greater than the discharge pressure. From Table 1 we find the head in feet equivalent to 1 pound per square inch pressure of lubricating oil is 2.5 feet. Thus the equivalent head for the gravity system will be from 75 to 90 feet and for the pressure system 60 to 75 feet.

The oil horsepower is found in the same manner as the

water horsepower of the feed pump. The I.H.P. and steam consumption are also found in the same manner, except that Fig. 9 is used for obtaining the mechanical efficiency and water rates.

EXAMPLE

Twin screw, 6,000 S.H.P. on each shaft. Cross compound single reduction gear. Stroke of lubricating oil pump = 14 inches. Gravity system used. Find oil pumped and steam consumption of the lubricating oil pump.

Oil pumped per minute per unit = $[(0.025 \times 6,000) + 100] \times 0.75 \times 1.20 = 225$ gallons per minute.

Pounds per minute = $225 \times 7.72 = 1,738$.

Pressure of pump discharge = 22 pounds.

Total head = $22 + 10 = 32$ pounds or $32 \times 2.50 = 80$ feet.

Oil H.P. = $\frac{1,738 \times 80}{33,000} = 4.21$.

Mechanical efficiency from Fig. 9 = 0.795.

I.H.P. = $4.21 \div 0.795 = 5.3$.

Water rate from Fig. 9 = 151 pounds.

Steam consumption for each pump = $5.30 \times 151 = 800$.

Steam consumption for both pumps = $800 \times 2 = 1,600$.

LUBRICATING OIL COOLING WATER PUMP

The water required for cooling the lubricating oil is, in most cases, taken from one of the other pumps (generally the sanitary pump) but when it is supplied by a separate pump, calculations should be made for the steam consumed by it. The weight of water required may be found by the following formula:

$$Ww = \frac{Wo(t_1 - t_2)}{t_4 - t_3} \times S$$

Ww = weight of water pumped in pounds per minute.

Wo = weight of oil passing through cooler in pounds per minute.

t_1 = degrees F. of oil entering cooler.

t_2 = degrees F. of oil leaving cooler.

t_3 = degrees F. of water entering cooler.

t_4 = degrees F. of water leaving cooler.

S = specific heat of oil which can be taken at 0.5.

The values of $t_1 - t_2$ and $t_4 - t_3$ will depend upon the power developed by the unit and the temperature of the sea water. For calculating the steam consumption the former may be taken at 20 and the latter at 5 and, taking $S = 0.5$, the formula becomes,

$$Ww = \frac{Wo \times 20}{5} \times 0.5 = Wo \times 2.$$

The discharge at the pump is, as a rule, between 5 and 10 pounds. The equivalent head for a pressure of 1 pound per square inch of salt water is 2.25, thus making the discharge head from 11.25 to 22.5 feet. Assuming the suction head is balanced by the friction in the suction piping and the resistance of the pump valves, the total head will then be equal to the discharge head, which can be taken, for an average, at 15 feet.

The water horsepower will then be

$$\text{Water H.P.} = \frac{Ww \times h}{33,000} = \frac{Ww \times 15}{33,000} = \frac{Ww}{2,200}$$

or, if it is wished to express it in terms of Wo , it becomes

$$\text{Water H.P.} = \frac{Wo}{1,100}$$

As the steam used by this pump is not very large, it would seem that this last formula would be sufficiently accurate for all cases.

The rest of the calculations for steam consumption are made in the same manner as those for other pumps but using Fig. 9 for obtaining the mechanical efficiency and water rates.

EXAMPLE

From the previous example we find that the oil pumped (Wo) for each unit is 1,738 pounds per minute. Stroke of the oil cooling pump = 14 inches.

$$\text{Water H.P.} = \frac{Wo}{1,100} = \frac{1,738}{1,100} = 1.58.$$

Mechanical efficiency from Fig. 9 = 0.795.

$$\text{I.H.P.} = \frac{1.58}{0.795} = 1.99.$$

Water rate from Fig. 9 = 151 pounds.

Steam consumption = $1.99 \times 151 = 300$ pounds per hour.

Steam used for both units = $2 \times 300 = 600$ pounds per hour.

ASH HOISTING ENGINE AND ASH EJECTOR

On coal burning ships, it is necessary to have some method of disposing of the ashes. This is generally done by one of two methods. The first is to hoist the ashes to the deck and dump them overboard, the other is to eject them from the fire room directly overboard. The time necessary to calculate the amount of steam used would not be warranted as the amount is small, but an allowance of about 80 pounds of steam for every ton of ashes handled by either method would be sufficient. The weight of ashes may be taken at 8 percent of the coal burnt.

SUMMATION OF THE AUXILIARIES OF THE FIRST GROUP

To sum up the total steam used by the auxiliaries of the first group, when the ship is underway, we have the following weights of steam used:

	Pounds per Hour
Main feed pumps	4,690
Forced draft blowers (direct connected turbines) ..	6,530
Fuel oil pumps	640
Fuel oil heater and heating coils in tanks	1,710
Fuel oil transfer pump	256
Main circulating pumps (direct connected turbines) ..	10,190
Condensate pumps (direct connected turbines)	960
Air ejectors (without intercooler)	2,174
Engine and fire-room bilge pumps	1,124
Lubricating oil pumps	1,600
Lubricating oil cooling water pumps	600
Total	30,474

The data, from which these figures were derived, were obtained from tests made under ideal conditions with dry saturated steam and do not take into consideration the losses due to condensation in the pipes, moisture in the steam, the changes of conditions as found on board ships from those during a test and the probabilities that the alignment of the various auxiliaries not being as good on the ship as during the test. To allow for the above, an addition of 10 percent should be made, to obtain the steam consumption of these auxiliaries on a trial trip.

Under average operating conditions the steam consumption would be somewhat higher, unless the equipment is kept in first-class condition. For good average operation, an allowance of 15 to 20 percent should be sufficient, but if the ship is not kept up to what might be called good average condition, this addition may reach as much as 30 to 35 percent.

The total steam consumed by the auxiliaries of this group will be as follows:

Trial trip condition = $30,474 + 10 \text{ percent} = 33,500$ pounds.
Operating condition = $30,474 + 15 \text{ to } 20 \text{ percent} = 35,050 \text{ to } 36,570$ pounds.

In order to obtain the steam used by the auxiliaries of this group at reduced loads, proceed as follows (to illustrate the method the steam used for trial trip conditions will be used):

S. H. P. of Main Turbines	Percent of Full Load	Multiplier C from Fig. 3	Steam Consumption in Pounds Per Hour	
			At Full Load IV	At Reduced Loads V = IV $\times$ III
12,000	100.0	1.00	33,500	33,500
10,000	83.3	0.89	33,500	29,830
8,000	66.7	0.82	33,500	27,490
6,000	50.0	0.781	33,500	26,170

(To be continued)

Rolling Experiments on Ship Models*

Comparison of Behavior of Bulged and Unbulged Battleships of the Royal Sovereign Class

By M. P. Payne

THE experiments were undertaken to compare the behavior, as regards rolling, etc., of bulged and unbulged battleships of the *Royal Sovereign* class.

The ships were originally fitted with bilge keels, 350 feet long, but after the bulges were added, bilge keels were omitted, it being assumed that the greater metacentric height and consequent shorter period of rolling induced by the

that the unbulged vessels, with a metacentric height of 3.4 feet, deep loaded, and bilge keels, had a longer period and rolled less than those with bulges, no bilge keels, but a

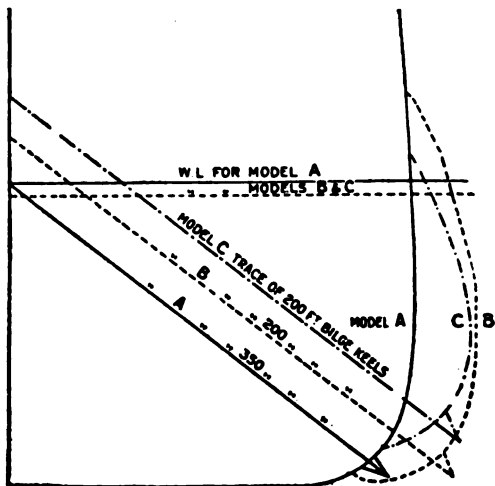


Fig. 1.—Midship Sections, Showing Bilge Keels

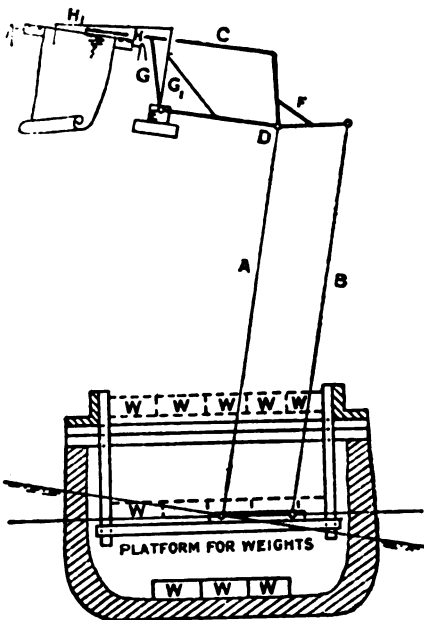


Fig. 2.—Diagrammatic Sketch of Rolling Recording Apparatus

bulges would be practically offset by the direct resistance to rolling offered by them. In service, however, it was found

*Abstract of a paper read before the Institution of Naval Architects, London, April 10, 1924.

A, B and C, single rods; DE, horizontal frame rocking on horizontal axis E; F, bell crank rocking on horizontal axis D in frame DE; G, frame (rocking on horizontal axis E) rotation of which is controlled by rod C; H, pen rod (recording angle of roll); G, rod secured to frame DE; H, pen rod (recording heave); W, ballast weight.

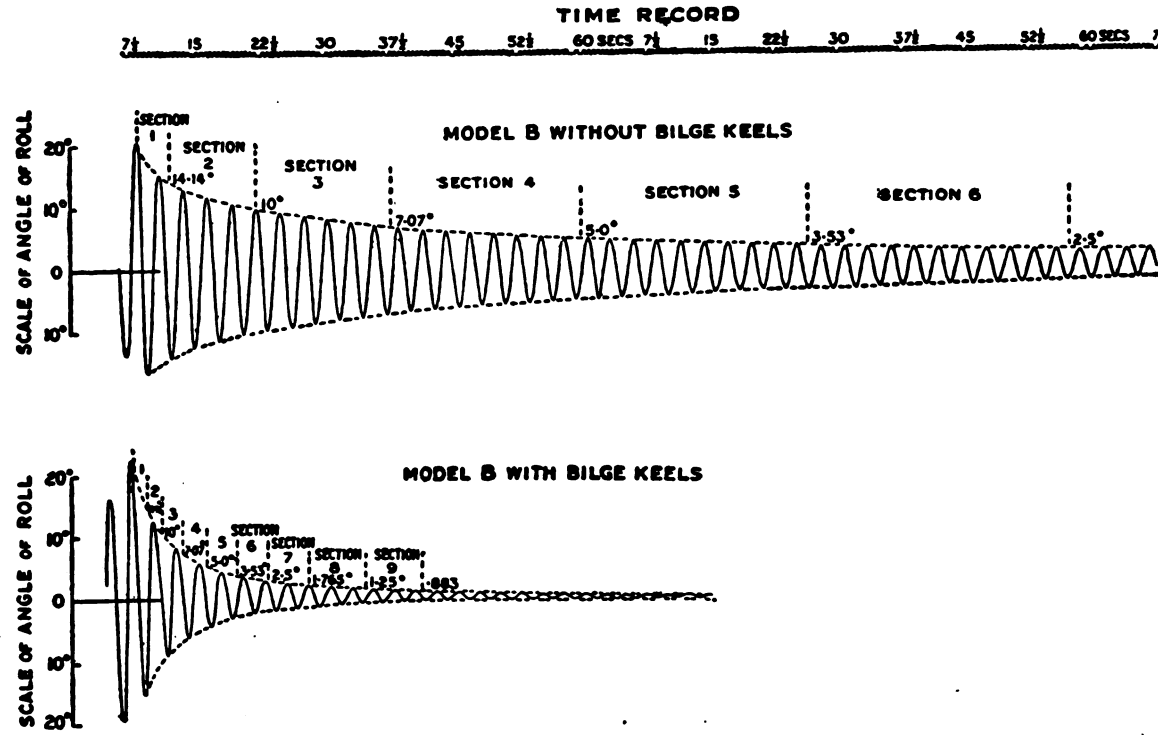


Fig. 3.—Specimen Rolling Diagrams, Still Water

metacentric height of 5.2 feet for the deep load condition. A report from the Atlantic Fleet showed the bulged ships as rolling from $12\frac{1}{2}$ to 15 degrees, each way.

HOW THE EXPERIMENTS WERE CONDUCTED

The experiments were conducted in the Haslar tank, the model being held at an angle of 45 degrees to the axis of the

to the model was adjusted so that the tension in the cord had practically no effect on the rolling.

Fig. 1 shows the midship sections of the three models tried, and Fig. 2 the general arrangement of the recording mechanism. It will be noted in the latter figure that rod *A* transmits the heave of the model and rod *B* the effect of the roll and heave combined. The models were arranged for

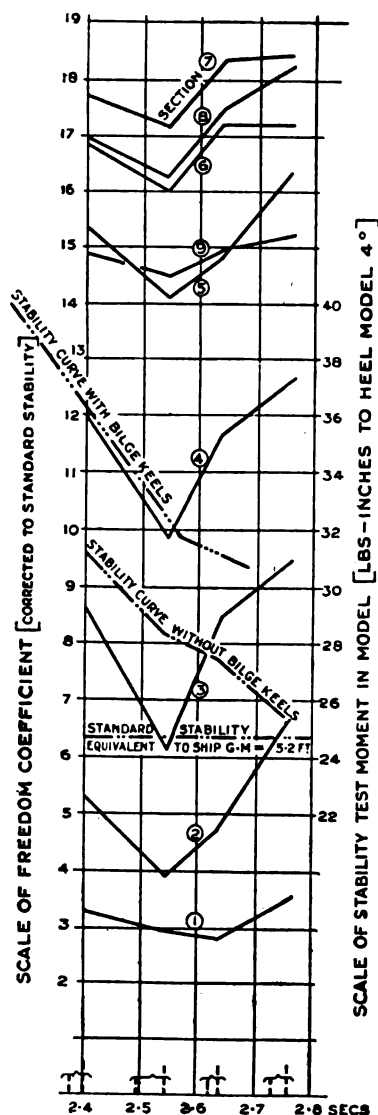


Fig. 4.—Curves of Freedom Coefficients to Base Period, Model B, Without Bilge Keels

tank by cords attached at each end and carried over pulleys to 5-pound weights at the free end. The point of attachment

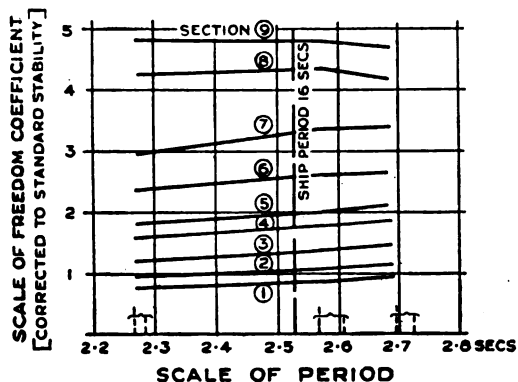


Fig. 5.—Curves of Freedom Coefficients to Base Period, Model B, With Bilge Keels

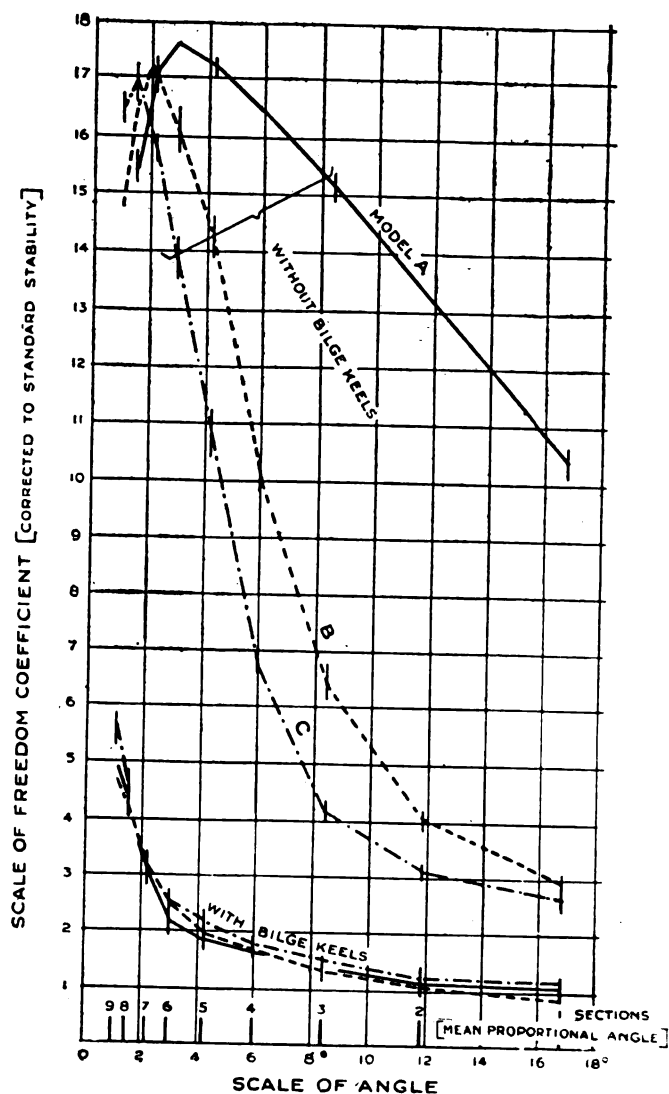


Fig. 6.—Freedom Coefficients (Corrected to Standard Stability)

	Corresponding Ship Particulars			
	Displacement	Mean Draft	G. M.	Period of Roll
Model A	30,600 tons	33.0 feet	3.4 feet	19 seconds
Model B	33,240 tons	31.5 feet	5.2 feet	16 seconds
Model C	32,000 tons	31.5 feet	5.2 feet	16 seconds

ballasting (W-Fig. 2), to permit a range of rolling periods corresponding to those actually obtaining in the ships.

In analyzing the results obtained, instead of differentiating the curve of declining angles (a rather long process), fair curves were drawn through the extreme angles of roll on the automatic rolling diagrams and ordinates to these curves at 20 degrees, 14.14 degrees, 10 degrees and so on, each angle

being $\frac{1}{\sqrt{2}}$ the preceding one (see Fig. 3). The number of

half-rolls between the successive ordinates were read off in decimals. The number of rolls in any section (space between adjacent ordinates) indicates the "freedom of rolling" or defect of extinction, and is referred to as the "freedom coefficient" for that section. The comparison of the different

models are made on the basis of these freedom coefficients.

As it was not always possible to ballast the models for different periods without some variation of metacentric height, for the prescribed period, corresponding to the ship's actual period, the metacentric height was made to correspond, as

Experiments with model *B* showed the period to be increased (about 3 percent) by the fitting of bilge keels.

EFFECT OF MOTION AHEAD UPON ROLLING

Further experiments, with models *A* and *B*, were undertaken to determine the effect of motion ahead upon rolling. These were conducted in much the same way as those at rest, and the results analyzed in the same manner. The results are shown, in the form of curves of declining angles, by Figs. 7 and 8.

It is clearly shown that motion ahead reduces rolling, and

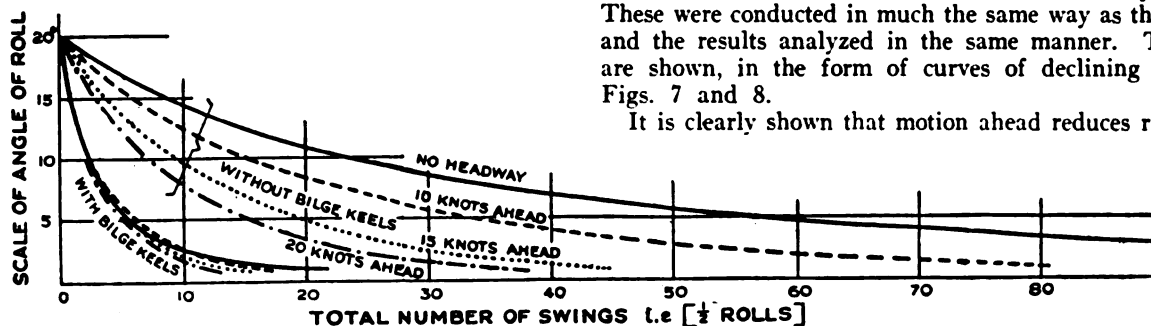


Fig. 7.—Variation of Curve of Declining Angles with Speed, Model A

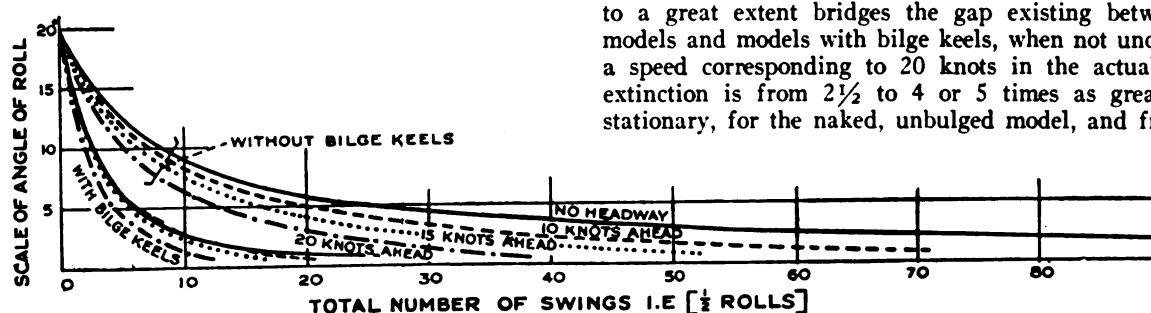


Fig. 8.—Variation of Curve of Declining Angles with Speed, Model B

to a great extent bridges the gap existing between naked models and models with bilge keels, when not underway. At a speed corresponding to 20 knots in the actual ship, the extinction is from $2\frac{1}{2}$ to 4 or 5 times as great as when stationary, for the naked, unbulged model, and from $1\frac{1}{2}$ to

nearly as possible, with that of the ship, while for other periods a correction for variation of G. M. was made in plotting the results.

Figs. 4 and 5 show the freedom coefficients for model *B*, plotted on a period base for the several section limits. The base represents actually the mean period of the last four sections (3.54 degrees to 0.885 degree), the mean period for the first three sections (20 degrees to 7.07 degrees) being indicated by bracketed lines for each period. The successive spots for each section, belonging to the successive grades of period, are joined by straight lines as are also the stability values (see Fig. 4) which show the moment differences observed in the model for 4 degrees difference of keel, as measured by an inclining experiment after each set of rolling experiments.

In Fig. 6 is shown a cross diagram at an abscissa value corresponding to the prescribed period and plotted on a base of angle of roll for each model.

RESULTS

The results show that the freedom coefficients are very sensitive to period and that with the unbulged model there is a tendency for freedom to increase with period. Both the naked bulged models appear to have a minimum freedom coefficient (maximum resistance to rolling) at all angles, for a period of about 2.5 seconds (near the prescribed period). At the prescribed periods, both the naked bulged forms have much less freedom than the unbulged, except at the low angles.

The resistance to rolling, as indicated by the smallness of freedom coefficients (Fig. 6), is markedly superior in the naked bulged forms as compared with the naked, unbulged; but in the latter, with bilge keels added, it is much greater than in the naked, bulged model. When relative small bilge keels are fitted to the bulged models, there is not much difference between the three forms.

3 or 4 times for the naked, bulged form. When bilge keels are fitted, the effect of headway on rolling is much less impressive and almost negligible at large angles.

It was found that there was a marked increase in G. M. with speed, more marked in the bulged than in the unbulged form. This accounts for a decline in rolling period

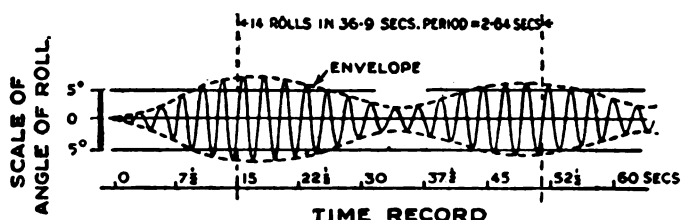


Fig. 9.—Typical Rolling Records, Model A, Without Bilge Keels, in Waves of 2.64 Seconds Period

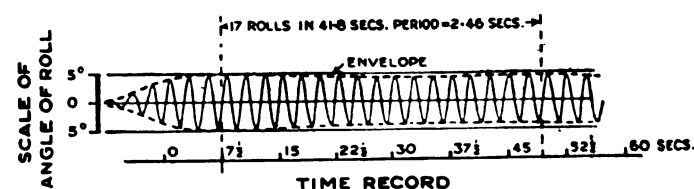


Fig. 10.—Typical Rolling Records, Model A, with Bilge Keels, in Waves of 2.46 Seconds Period

found with increase in speed, the period being approximately inversely proportional to $\sqrt{G. M.}$ at all speeds.

ROLLING AMONG WAVES

Experiments, of somewhat limited scope, relative to rolling among waves were carried out. With the naked models, (Continued on page 558)

Turbine Drive for Auxiliary Machinery*

General Advantages of the Steam Turbine for Driving Auxiliaries—Savings in Weight and Space

By Richard W. Allen, C. B. E.

WHILE steam turbines were used in the year 1907 for propelling purposes, very few were installed for any auxiliary purpose until some years after this date. The first small turbines compared unfavorably with the high-speed, forced lubrication reciprocating engines and it was only after years of experiment that such improvements were effected as to lead to the change in opinion. During the past few years there has certainly been an increasing de-

relative cost between a reciprocating and a turbine set must thus be made on a very broad basis and not by simply comparing the units of machinery only.

STEAM CONSUMPTION

With regard to the question of steam consumption, it must at once be admitted that up to the present and for the steam conditions generally prevailing for the auxiliary units, the turbine cannot show any initial advantage over the reciprocating engine; but the high-speed, small diameter turbines that have been lately adopted show steam consumptions that are not inferior to those of the high-speed reciprocator. Also a modern turbo unit will run for years without appreciable wear, and is better adapted to the use of highly superheated steam.

Thus, taking into consideration the question of overhaul, renewals and reliability over a long period of running, it may be said that the turbine is superior to the reciprocating engine.

The present practice is to use an impulse turbine of the axial flow type, selecting such a number of wheels as will give the most simple construction consistent with low steam consumption.

With the steam conditions usually specified, it is quite possible to use a single impulse wheel, this being of the velocity-compound type, so that the pressure inside the turbine casing is the same as the exhaust pressure and the shaft packing at the high pressure end is the same as that at the low pressure end. This one wheel meets all requirements for reasonable economy under the usual back-pressure conditions of 20 pounds, but where the back pressure is lower, for example, 5 pounds, it may be advisable to add a second stage single-row wheel.

REDUCTION GEARS

Reduction gears, which have played such an important part in the introduction of the turbine to the main propelling machinery, have served also with the auxiliary machinery to an equally important degree, in permitting the coupling of a high-speed and high-efficiency turbine to a low-speed generator.

APPLICATION TO CIRCULATING PUMPS

Turbine drive has now been successfully applied to large circulating pumps. Centrifugal pumps, in many cases, can be coupled direct to the turbine. The tendency, however, is to introduce a reducing gear in order to obtain better economy in steam consumption. It is of interest to compare

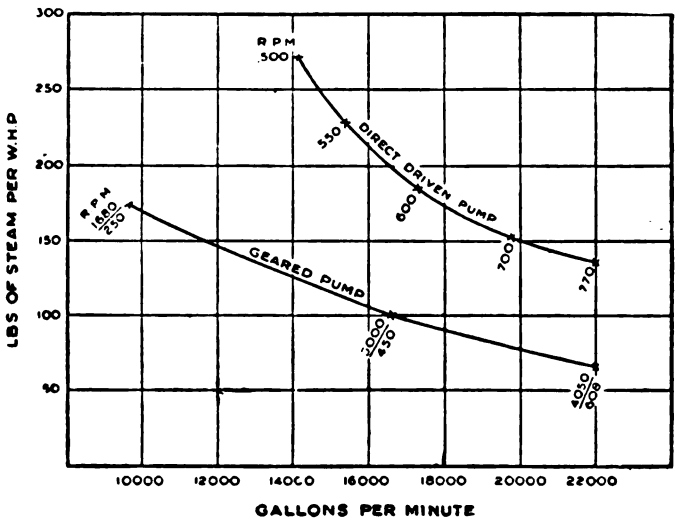


Fig. 1.—Comparative Steam Consumptions of Turbine Driven Circulating Pumps, Direct and Geared

mand for turbine-driven generators and circulating pumps and other auxiliaries.

In order to supplant the steam engine, the turbine needs primarily to be simple and reliable, and, secondly, to compare favorably on the score of cost, weight and steam consumption. The advantage of the turbine on the ground of evenness of torque, flexibility and cleanliness, enables it to take the premier place as auxiliary prime mover in ships, and the ease with which it is adaptable to horizontal, vertical or any inclined position of its spindle, not only has the advantage of enabling the auxiliary to be designed to fit into the most convenient place in the ship, but also leads to a direct saving of weight and expense by doing away with a certain amount of structural support. Any comparison of

*From a paper read at the spring meetings of the sixty-fifth session of the Institution of Naval Architects, London, April 10, 1924.

TABLE I.—ELECTRIC GENERATORS

	Turbine			Engine			Cubic Feet Space Occupied		Percent Saving in Space
	Length ft. in.	Width ft. in.	Height ft. in.	Length ft. in.	Width ft. in.	Height ft. in.	Turbine	Engine	
400 kilowatts	14 0	7 0	5 6	21 0	10 0	12 0	540	2,500	79
100 kilowatts	8 6	5 0	4 6	10 9	5 3	8 0	190	450	58
Circulating Pumps									
29,000 gallons per minute 38-foot head.....	12 0	7 0	7 0	12 0	7 6	12 0	590	1,080	45
22,000 gallons per minute 22-foot head.....	5 6	4 9	10 0	10 3	5 0	10 3	260	525	50
Boiler-room Fans									
50,000 cubic feet per minute 6-inch water gage....	6 6	5 0	5 0	5 3	7 4	8 6	162	325	50

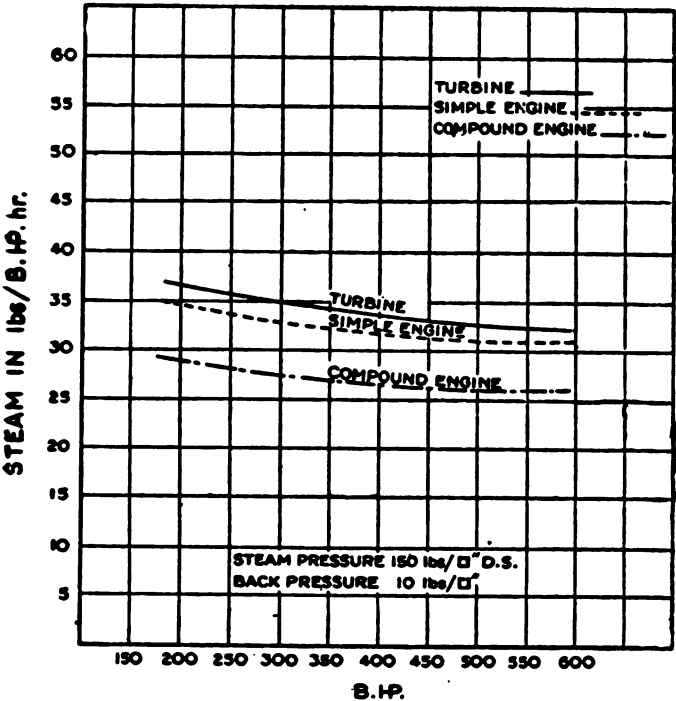


Fig. 2

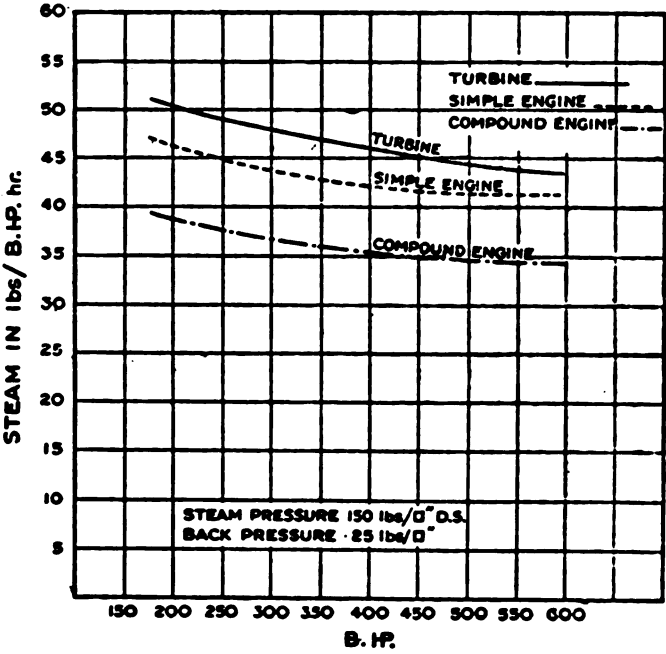


Fig. 3

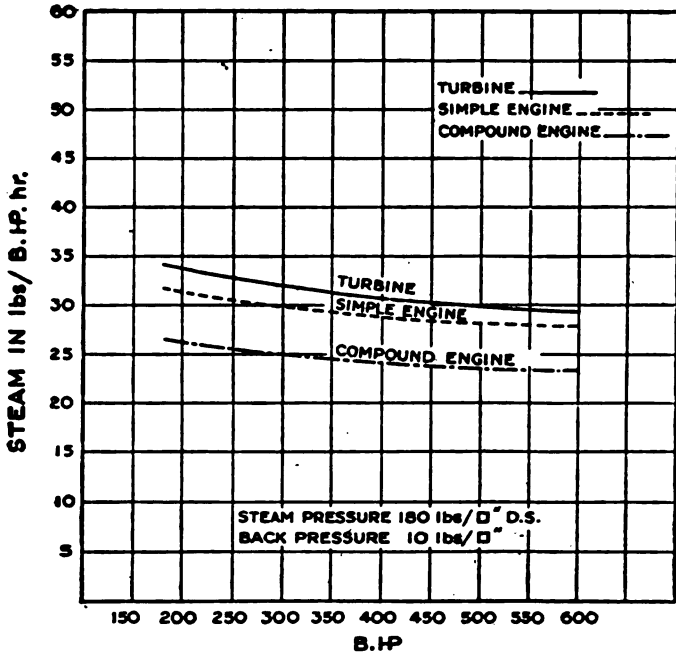


Fig. 4

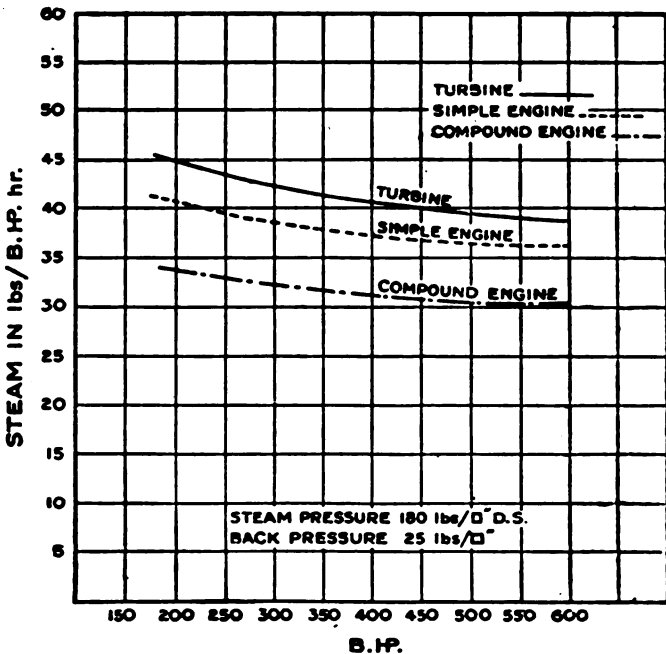


Fig. 5

Figs. 2, 3, 4 and 5 show comparative steam consumptions of turbines, simple engines and compound engines.

the steam consumption of these two types under the same steam conditions. In the case of the direct-driven pump the particulars are as follows:

Revolutions per minute	770
Quantity of water delivered per minute, gals.	22,000
Head, feet	22
Steam consumption, pounds per hour	19,870
Pounds of steam per water horsepower	135

With regard to the gear-driven set, which has the same output, the following are the figures:

Revolutions per minute (pump)	600
Revolutions of steam turbine	4,000
Quantity of water delivered per minute, gals.	22,000
Head, feet	22
Steam consumption, pounds per hour	9,744
Pounds of steam per water horsepower	66

The curves on Fig. 1 indicate very clearly the saving in steam consumption over a considerable range of output of the geared set as compared with the direct-driven set.

A comparison between an engine-driven circulating pump and a geared turbine pump shows that in steam consumption the latter is not inferior on test, as shown by the following particulars giving the steam consumption of an engine-driven pump of similar capacity to the turbine-driven pumps quoted above.

Revolutions per minute	515
Quantity of water delivered per minute, gals.	20,250
Head, feet	22.2
Steam consumption, pounds per hour	9,080
Pounds of steam per water horsepower	66.6

(Continued on page 558)

The Practical Solution of Some Shipboard Problems*

An Automatic Cut-Out Switch for Refrigerating Machines — Oil, Feed and Salinity Indicators — Oil Detector

By Lieutenant C. C. McMillan, U. S. C. G.

WITH refrigerating machines of the dumb bell type, it is essential that a constant supply of cooling water be maintained about the drum containing the compressor while the machine is in operation.

Should the supply of cooling water be stopped for several minutes the temperature in the compressor will rise excessively. If this condition continues the compressor pressure will increase until the counter weight revolves with the

the circuit and stop the machine. The impracticability of such a device is obvious. To overcome this difficulty the contrivance shown in Fig. 1 was conceived and made aboard the Coast Guard Cutter *Mojave* from such material as could be found in the scrap pile.

The device consists of two cylindrical chambers secured together and provided with a port at the lower end to allow water to pass freely from one chamber to another. The smaller contains a perforated tube which is connected outside the chamber to a $\frac{1}{8}$ inch pipe leading to the cooling water supply line. This tube is considerably larger than this $\frac{1}{8}$ inch pipe and is an expansion space thus eliminating the violent agitation that otherwise would result should the water be injected directly to the chamber at service pressure. There is also another tube to which the water flowing into this chamber is freely discharged, but it is of sufficient length to maintain a predetermined water level. Near the lower end of this tube is a small orifice through which the water in the chamber escapes slowly after it has fallen below the upper end of the tube.

The larger chamber contains a float. To this float is attached a long stem which passes through a guide in the top cover of the chamber.

The switch consists of a simple arrangement of three levers and one spring constructed so as to snap in and out of contact. A positive contact is assured by means of two small rods (insulated from the mechanism) which dip into the mercury contained in two iron cylindrical cups. This method also does away with troubles due to friction, burnt and corroded contacts, etc., as is often encountered in other switches.

The entire switch is mounted on an insulated base which is secured to the larger chamber and is operated by one of the levers connected to the long stem attached to the float.

AN OIL INDICATOR

Owing to the necessity of frequent soundings of ship's fuel tanks to determine the amount on hand and expended in a given unit of time, considerable time was expended in obtaining the necessary data prior to the installation of the device shown in Fig. 2. However, since its installation this loss of time has been overcome and better and quicker results have been obtained.

The description of this device (indicator) follows: It consists of a 3-inch cylinder mounted on suitable bearings with a knurled knob attached to one end of the shaft to facilitate revolving the cylinder freely. The scale is made of steel, and is so laid out as to represent the tons in gallons, as shown on the original drawing. The scale is properly secured to bearing tops in dead line with the parallel center of the cylinder. It is graduated in gallons from zero to the maximum capacity of the largest tank. At the end of the cylinder just above the knurled knob the tube is divided into feet representing the depth of the tanks from zero to the maximum depth of the deepest tank. The smaller vernier is secured to the bearing top for use as a stop mark, and enables the feet to be divided into tenths for close calculation.

The curves representing those on the original drawing were laid out and colored red and black in order to be able to discern the different tanks being checked. A small plate with the tank number and its color is screwed to the bearing frame to avoid mistakes.

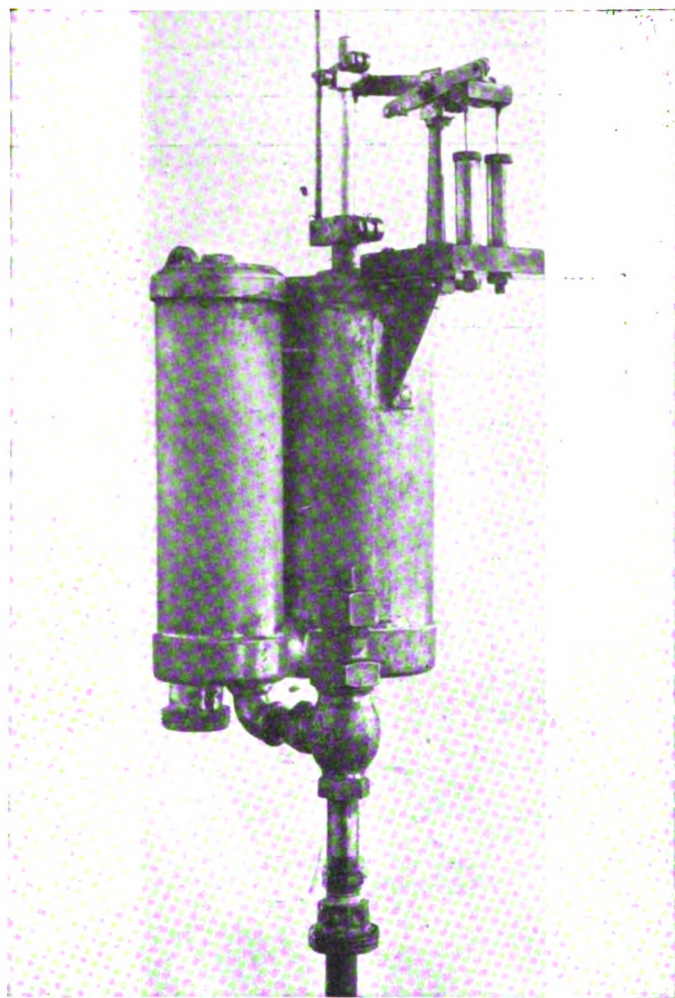


Fig. 1.—Automatic Cut-Out Switch

machine thus acting as a safety device protecting the machine against damage by excessive pressure, but it does not protect the machine against damage by jerking, and pounding caused by the revolving counterweight.

An automatic stopping device consisting of a simple contact breaker operated by a diaphragm which was connected to the condensing water supply by a $\frac{1}{8}$ inch pipe was originally installed with the refrigerating machine on the Coast Guard Cutter *Mojave*, but proved to be unsatisfactory owing to the extreme sensitiveness of the diaphragm arrangement. A slight variation in pressure of the water supply would break

*From the Journal of the American Society of Naval Engineers.

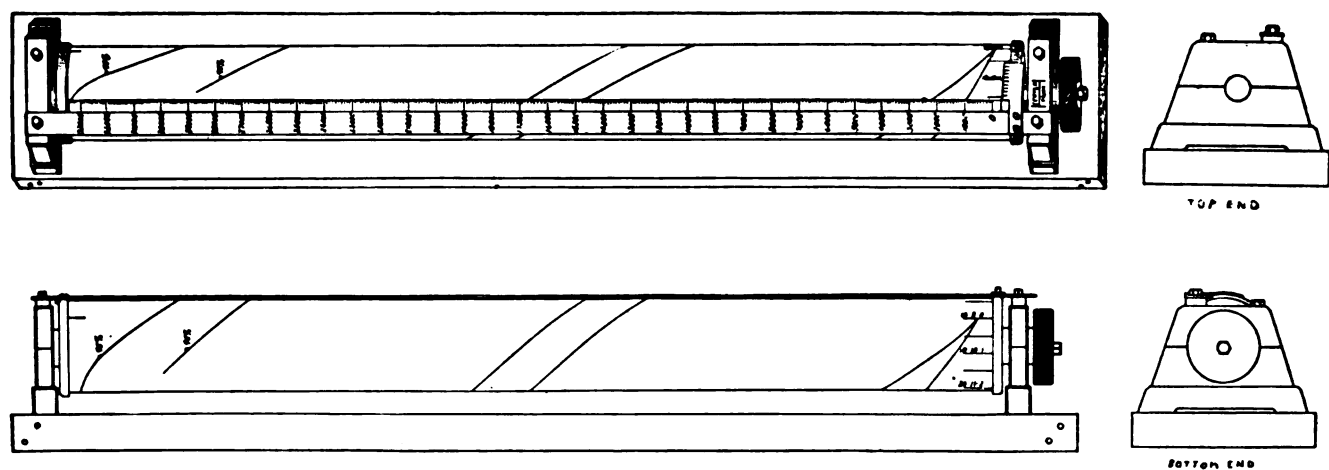


Fig. 2.—Oil Indicator for Measuring Amount of Oil in Tanks

When it becomes necessary to check the amount of oil in a tank the only information necessary is that derived from sounding, as the scale is in feet and inches and is set to correspond with the soundings, and the intersection of the curve line with the graduated scale gives the amount in the tank in gallons or vice versa.

This indicator may be constructed at very little expense, may be applied to any set of ship's tanks, and several tanks may be laid out on the cylinder.

In conclusion: This instrument has been in use on board

glance whether the feed is on or off, and the amount of water being used.

SALINITY INDICATOR

The electrical salinity indicator as installed on the Coast Guard Cutter *Mojave* is shown in Fig. 4 and consists of the following:

- (1) A 0 to 15 scale portable voltmeter.
- (2) Twelve dry cell units.

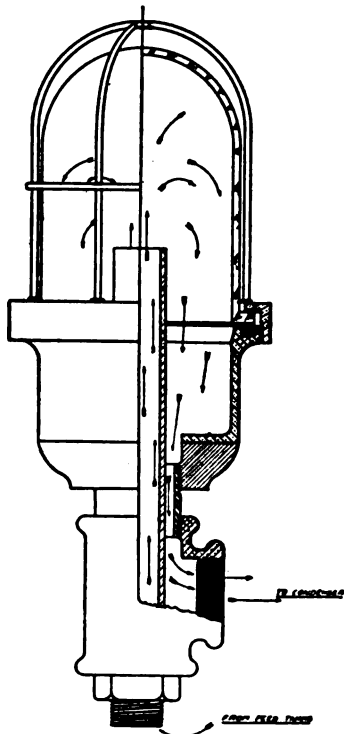


Fig. 3.—Feed Water Indicator

the Coast Guard Cutter *Mojave* for some time, and in practical use has proven to be highly satisfactory and reliable.

FEED INDICATOR

This is shown in Fig. 3; it consists of a standard steam tight lighting fixture with the glass piped as indicated by the legend on the sketch. When in operation this instrument shows a stream of water, the flow of which is indicated by the arrows. This enables the officer of the watch to detect at a

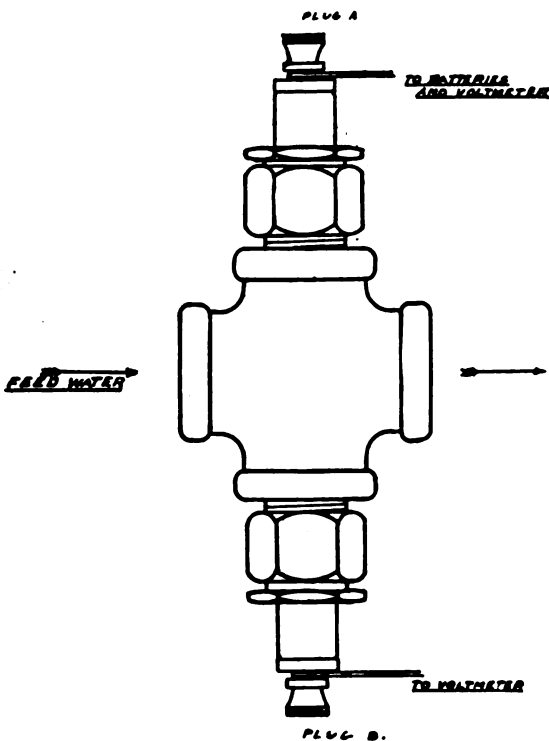


Fig. 4.—Electrical Salinity Indicator

- (3) Two 1/2-inch spark plugs.
- (4) One 1/2-inch standard cross.

The voltmeter is mounted on the control platform in the engine room and instantly records any change in the condensate. With the water below one grain of chlorine per gallon the voltmeter registers 0. With sea water the voltmeter registers 14.1 volts. The scale has been graduated into grains chlorine per gallon between 0 and 14.1 volts.

The twelve dry cells give an applied electromotive force

of 18 volts across the terminals of the spark plugs which are located on the filter tank in the fireroom.

The spark plugs are of the ordinary commercial $\frac{1}{2}$ -inch standard type. The points on the screw points are removed. The plugs are screwed into the $\frac{1}{2}$ -inch pipe cross. A circulation of water is maintained across the points in the following manner: A $\frac{1}{2}$ -inch pipe connects the initial condensate compartment with the cross containing the spark plugs, and from the cross a similar pipe leads into the last compartment of the tank. On the end of this pipe a cap is fitted with a $\frac{1}{32}$ -inch hole drilled through the end.

The principle on which this indicator functions is as follows: The resistance of water with a low chlorine content is very high with the consequent low reading on the voltmeter scale. As the chlorine content increases in the condensate, the resistance of water flowing between the two plugs decreases in direct proportion to the increase in salinity.

The wiring is as follows: The positive electrode of the battery is connected to plug "B" and the plug "A" is connected to the positive terminal of the voltmeter. The negative terminal of the voltmeter is connected to the negative terminal of the battery comprising a simple loop circuit.

OIL DETECTOR

This is shown in Fig. 5 and is considered self-explanatory. It consists of an airport glass let into the frame of the feed

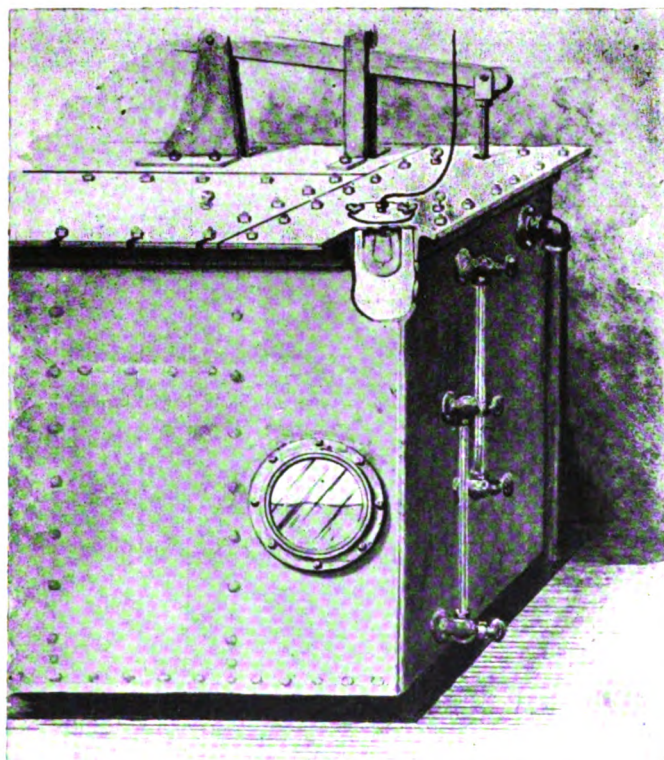


Fig. 5.—Oil Detector

tank and so arranged in place that the water level in the tank is in the middle of the glass and constantly in sight with a light inside of the tank. The surface of the water is plainly in sight and the presence of any oil in the water is detected at once.

THERMIT WELDING FOR SHIP REPAIRS.—In a circular issued on July 4, Lloyd's Register of Shipping, London, announces its decision to accept Thermit welding for temporary repairs to such parts of the hull structure of a ship as do not have to sustain torsional stresses. It is required, however, that such temporary repairs shall be carefully examined periodically, and, if below the water line, at each dry docking.

Rolling Experiments on Ship Models

(Continued from page 553)

when near synchronism, the experiment had to be stopped when the roll exceeded 20 degrees (immersion of gunwale). The naked, unbulged form appeared to "build up" more rapidly than the bulged although the superiority of the latter was not very decided, except near synchronism. The advantage of bilge keels was shown to be no less marked than in the still water experiments, as the maximum roll, near synchronism, was never over 7 degrees, as compared with 20 degrees or more with the naked models.

Typical rolling records among uniform waves are shown by Figs. 9 and 10.

BILGE KEEL RESISTANCE

The increase in resistance, due to bilge keels, was measured, and found to be as follows:

Model	Added Surface	Added Resistance $\odot$
A2	4,300 square feet	0.074
B2	2,075 square feet	0.041
C2	2,240 square feet	0.049

For all three vessels, $E. H. P. = 2.421 \odot V^3$.

Experiments were also made, by means of vanes, to determine the angle of flow to the line of bilge keel, as fitted. A downward flow, across the bilge keel plane, was indicated in the forebody and an upward flow across it in the afterbody. It would appear that the results are such that no general rule for this flow can be deducted, each individual case having to be considered on its own merits.

[Experiments, similar to those last mentioned, relative to stream line flow, but of a more extended character, are described in a paper by Naval Constructor D. W. Taylor, Transactions of the Society of Naval Architects and Marine Engineers, 1907.—THE EDITORS.]

Turbine Drive for Auxiliaries

(Continued from page 555)

SPACE AND WEIGHT SAVINGS

The space for the auxiliaries is often cramped, but the turbine-driven auxiliary, by reason of the smaller space occupied, its simplicity of construction and the accessibility of its vital parts for overhauling, may be placed where the engine-driven auxiliary could only, if at all, be placed to serious disadvantage.

The comparison of the space occupied by the turbine- and engine-driven auxiliaries is shown by the Table I.

It is worthy of note that as the power of the auxiliary increases the advantage in space occupied by the turbine-driven set becomes more marked.

A considerable saving in net weight can be shown when the turbine-driven auxiliary is substituted for its engine-driven counterpart, and Table II shows what can be done in this respect—the weights being those of exactly similar power and capacity.

TABLE II.—WEIGHTS OF ELECTRIC GENERATORS, GIVEN IN HUNDREDWEIGHTS PER SET

	Turbine	Engine	Percent saving in weight
400 kilowatts	254	686	63
100 kilowatts	78	160	51
<i>Circulating pumps</i>			
29,000 gallons per minute 38-foot head	145	230	37
22,000 gallons per minute 22-foot head	90	105	15
<i>Boiler-room fans</i>			
50,000 cubic feet 6-inch water gage	19	26	27

Questions and Answers Relating to Naval Architecture and Marine Engineering

Conducted by James L. Bates, Naval Architect, and W. B. Newton, Marine Engineer

This department is maintained for the purpose of answering all questions relating to ships and their machinery. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Machinery Fastenings

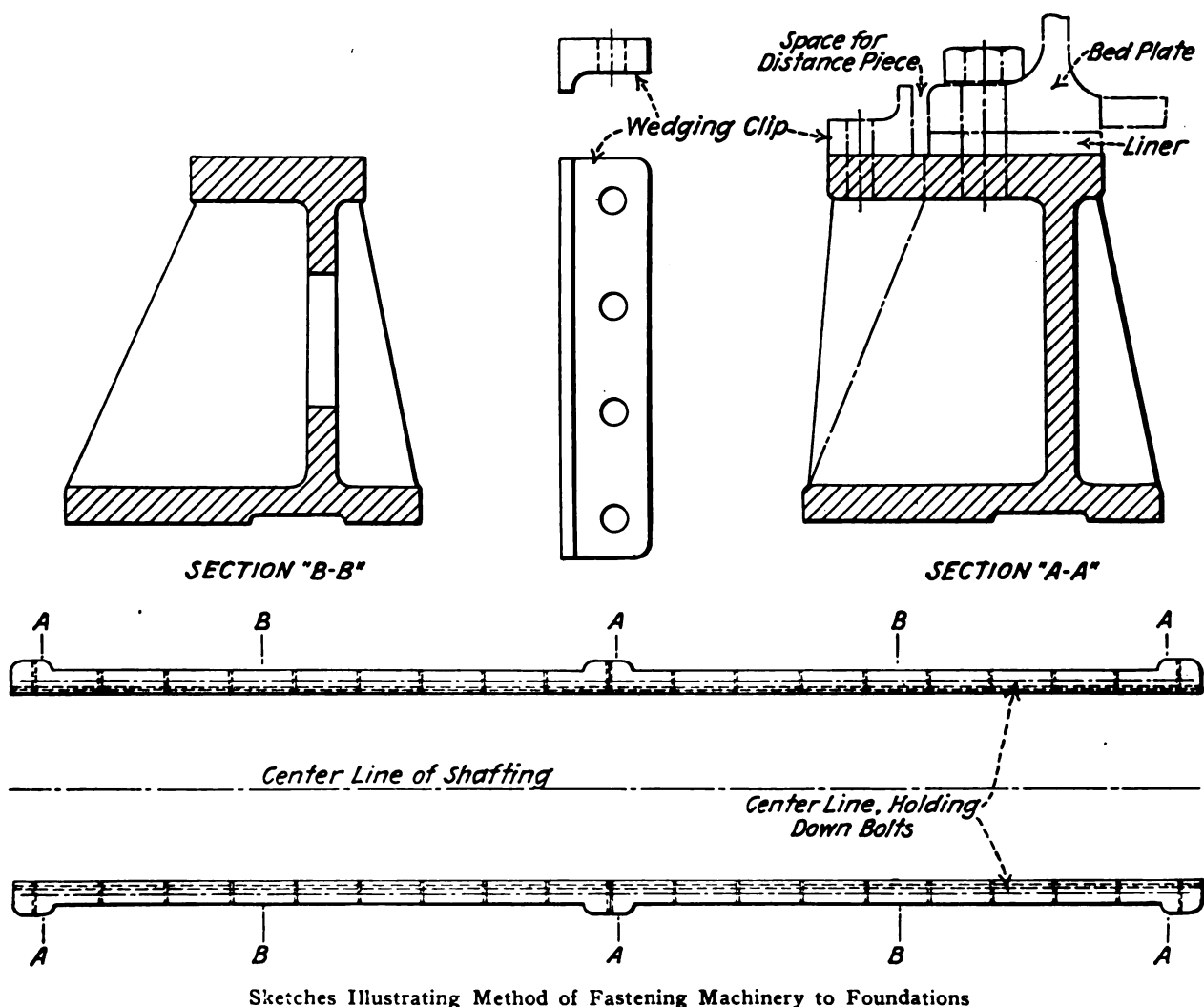
Q. (1,269).—I am in receipt of your answers to my question No. 1,263. I do not quite comprehend the methods given for securing machinery to their foundations. Although the first sentence starts with "In the case of auxiliary machinery," it appears to me that "accurate alignment" and "to relieve the holding down bolts from shearing stresses" refers to propelling machinery. Does the "true surfaces" to which the bed plates should be fitted mean, say for a propelling engine, that the heavy $\frac{3}{4}$ to $1\frac{1}{4}$ -inch foundation plate should have a light cut planed from it, so that it is absolutely true? I do not quite understand how the "keys" and "chocks" are fitted and secured. The 125 horsepower engine to which I referred runs at 250 revolutions per minute.

A. (1,269).—(See Q. 1,263 in issue of August, 1924.)—In the original reply to this question there was intended to be no distinction between auxiliary engines and propel-

ling engines provided only both were reciprocating as distinguished from turbine. Limiting the subject further now to small powers (500 brake horsepower or less) and to relatively high speeds (200 to 450 revolutions per minute or more) the following should prove satisfactory:

A sufficient number of holes for holding-down bolts should be reamed and the bolts carefully fitted to secure the engine in its fore and aft position. The remaining holding-down bolt holes should be either elongated or preferably bored large for clearance sufficient to allow for the fore and aft expansion of the bed plate. The number and size of holding-down bolts should be sufficient to keep the engine on its seating when the vessel is rolling. (The engine manufacturers will probably furnish these data.)

In order to retain the proper alignment of the engine, while permitting free fore and aft expansion of the bed plate, chocks or wedging clips should be riveted to the foundation casting on either side and near the ends of the bed plate. There should be an allowance of $\frac{3}{8}$ or $\frac{1}{2}$ inch between the



Sketches Illustrating Method of Fastening Machinery to Foundations

faces of the wedging clips and bed plate to provide for the fitting of distance pieces.

In order to permit of the vertical adjustment requisite to accurate alinement, mild steel liners $\frac{3}{4}$ to 1-inch in thickness should be provided. These may be fitted in convenient lengths but each unit should take at least two holding-down bolts.

The above method is considered particularly satisfactory in that while it is both positive in action and inexpensive to install it also permits of easy and accurate adjustment if required.

In case your foundation girders are already completed and do not provide sufficient width for securing the wedging clips to them, it may be possible to fit keys between the girder and bed plate so as to permit the expansion of the bed plate fore and aft while eliminating transverse motion.

If neither of the foregoing methods are practicable, it will probably be necessary to depend upon the shearing strength of the holding-down bolts to prevent transverse motion. In this case the bolt holes should be elongated fore and aft and the liners between bed plate and girder casting kept to the minimum thickness practicable.

Speed and Power Problem

Q. (1,273).—Can 15 miles per hour speed be obtained with a single screw propeller, driving a steel hull with ferry super-structure 135 feet long, 24 feet beam, 7 feet draft, it being understood that the model of the hull would, of course, be good? If possible, I would appreciate your estimate as to what power would be required to drive this hull at 15 miles per hour. The depth of the water would be about 15 feet.

A. (1,273).—It is not possible to answer your questions definitely because the information furnished is incomplete. The dimensions given might reasonably apply to a vessel of displacement anywhere between, say, 325 and 400 tons. Further, you do not state the type of machinery contemplated nor the service in view, so as to make it possible intelligently to estimate the weights. However, the following data may give you an idea of the limits between which you might expect to work were the vessel intended to operate in deep water:

	Light	Heavy
Length, feet	135	135
Beam, feet	24	24
Draft, feet	7	7
Displacement, tons	325	400
Prismatic coefficient	0.56	0.65
Displacement—length coefficient	132	163
E.H.P. (bare hull) at 15 statute miles per hour (deep water)	260	455
Corresponding B.H.P. (deep water) about	520	910

The above figures are considered reasonable but would be considerably modified by certain changes in assumptions.

It is apparent that the moderate powers shown above could readily be developed by single screws.

So much for deep water. Model experiments carried out both in this country and abroad indicate the following relations between economical speeds and channel depths.

Channel depth, feet	15	20
Corresponding limiting economical speed, statute miles	12-12 $\frac{3}{4}$	13 $\frac{3}{4}$ -14 $\frac{3}{4}$

These limiting economical speeds in the depths of channel shown require noticeable increases of power over those for the same speeds in deep water, roughly say from 25 to 50 percent. Above this point an increase in speed of a mile might involve increasing the power from three to five times.

If the 15 feet quoted represents a fair average of the depth of channel over the run contemplated, the writer believes the possibility of obtaining a speed of 15 miles with the dimensions quoted to be decidedly problematical.

It is possible to secure more favorable results by decreasing the draft from the 7 feet you suggest. Let it be assumed that we have the following dimensions:

Length, feet	135
Beam, feet	28
Draft, feet	3.5
Displacement, tons	225
Prismatic coefficient	0.601
Displacement—length coefficient	91.6

This gives a ratio of channel depth to draft of 4.28. This vessel would require about the powers shown below for the speeds indicated.

Speed statute miles	E.H.P. deep water	E.H.P. in 15-ft. channel	S.H.P. in 15-ft. channel
12	130	170	354
13	180	315	656
14	240	445	928
15	315	...	...

It will be noted that though the displacement and draft of this last vessel have been much reduced over those at first selected there is still some uncertainty about reaching a speed of 15 miles.

The writer considers this speed (15 miles) possible on the length and in the channel depth specified. However, in order to realize it a very small draft, say 30 or 33 inches, a light hull and light high speed machinery will be required. If compatible with the other conditions to be met, the required speed could be reduced to 12 or 13 miles, your problem would be much simplified, your operating and other expenses reduced and possibly your net income increased.

While the above may be taken as reasonably correct for the conditions assumed, any steps toward the design and actual construction of a vessel to meet such severe conditions could wisely be taken only upon the advice of one thoroughly familiar with the problem presented.

Vacuum for Reciprocating Engines

Q. (1,274).—In a recent article in MARINE ENGINEERING AND SHIPPING AGE, by Commander Dinger, the engineer is told to maintain all the vacuum that the plant is capable of producing. Does this mean in turbine ships only, because Sterling and other books speak of the mistake of carrying the vacuum too high on reciprocating vessels? What do you consider the proper vacuum on reciprocating installations?—G. H.

A. (1,274).—It will be seen on reference to a set of steam tables that the volume of one pound of dry steam at 28 inches vacuum is nearly double that at 26 inches vacuum. In order to design an engine to take care of this large increase, there must be a large increase in the low pressure cylinder, its piston and valves, accompanied by a loss in mechanical efficiency. To obtain a high vacuum larger air and circulating pumps will be required, resulting in a decrease in temperature of the water discharged by the air pump and an increase in steam consumption for these auxiliaries. While a high vacuum may decrease the steam consumption of the main engine per horsepower, it can be seen that a point may be reached beyond which it will cost more in the expenditure of fuel per horsepower to produce that vacuum than the apparent gain. It has been found that the point of best overall efficiency may be attained at about 26 inches of vacuum.

When an attempt is made to carry a high vacuum at full power on an engine designed for 26 inches, the back pressure in the low pressure cylinder can rarely be brought below 4 pounds absolute, due to the now much greater volume of exhaust attempting to pass through ports and passages designed for the low vacuum. This fact, together with the great difference between inlet and outlet temperatures, causes such a considerable increase in condensation that there is but little thermodynamic gain.

In view of the above, it is believed that commander Dinger referred to turbine rather than reciprocating engine installations.

POWER SHOW.—The Third National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, December 1 to 6.

NEW BOOKS

SHIP JOINERY. By S. G. Duckworth, A. B. I. C. C. Size, 5¼ by 9 inches. Pages, 215. Diagrams and illustrations, 700. New York: 1924. E. P. Dutton & Company.

Though there are already many handbooks dealing with carpentry, joinery and cabinet-making, there has hitherto been no separate book devoted to the important branch of joinery-work required in a modern ship. In this volume the author describes tools, methods and principles, as well as the details of practice, so adequately, and with the aid of so many illustrations, that any journeyman carpenter will be greatly aided in adapting himself to this new branch of woodworking.

DIESEL ENGINES. Size, 9 by 12¼ inches. Pages, 70. Illustrations, 200. Berlin, 1924: The Verein Deutscher Ingenieure.

The German Society of Engineers has recently published a compendium, in English, of papers read before the Diesel Engine Congress of June, 1923. These papers were originally published last year, but have been supplemented in the present publication.

While the papers are practically confined to German research in connection with Diesel engineering, the whole subject of the development of this type of machinery is covered. The discussion of heat transference appears to us to strike at the foundation of Diesel design and the investigations of scavenging efficiency are also of particular importance.

Other papers of interest deal with fuels, quantity production of small engines and increasing the output of four cycle engines.

The illustrations are excellent and while, in certain instances, a rather more detailed explanation would have materially increased the value of the papers, the book contains a vast amount of information, in compact form, and will be welcomed by everyone concerned with the design and construction of Diesel engines.

The American Submarine

Reviewed by J. Barraja-Frauenfelder

THE BIRTH AND DEVELOPMENT OF THE AMERICAN SUBMARINE. By Captain Frank T. Cable. Size, 5¾ by 8¾ inches. Pages, 337. Illustrations, 20. New York, 1924: Harper & Bros.

In a book devoted to the impartial and historical facts forming the chain of events and the steps in the development of the American submarine credit should be given to all those who have contributed to its development. To a man who has been so closely associated with the late John P. Holland as Captain Cable was and has shared with him the troubles and tribulations common to all inventors of new and revolutionary devices in overcoming official resistance and red tape, the efforts of others fall into insignificance. The lack of due recognition of the work of Simon Lake and his struggle against great odds to have his contribution to the art of submarine design, construction and navigation recognized, is the only void traceable in this otherwise interesting and meritorious contribution to submarine literature.

The first part of the author's discussion covers the moral side of submarine warfare as related to the political situation of J. P. Holland's time. In this he has contributed very valuable information to submarine literature. His exposure of Holland's vicissitudes is, it is presumed, as faithful a story of this brilliant pioneer's efforts as has yet appeared in print.

Slight imperfections appear concerning the types of vessels adopted by various navies, that is "diving" vs. "even keel"

type. Holland and his successors, in designing vessels of this type, strenuously adhered to stern diving rudder control for diving purposes, and did not adopt bow diving rudders until forced by necessity by the growing length of the vessels, when difficulty in getting the vessel's nose under water without the additional help of the bow rudders forced this improvement. This is practically adopting the even keel principle in an indirect way.

Several nations, experimenting on their own, adopted the principle of stern and bow diving rudder control long before the Holland type adopted it, namely, France, Italy and Germany. Contrary to the author's belief the German boats were notoriously Lake imitations as far as rudder control, shape of hull, watertight superstructure and other minor features were concerned, and the number of vessels not of the diving type in service during the time the Holland still adhered to stern diving control only, was by no means negligible, in fact this number was so marked that it forced recognition, so much so that the purely diving type is now considered unsafe and obsolete.

The concluding paragraphs of the book treat at length again the moral side of submarine warfare in connection with disarmament and the political situation of today.

Captain Cable's contribution as a whole and neglecting the minor shortcomings above mentioned deserves a place of prominence on any submarine bookshelf.

High Pressure Steam

Reviewed by Louis Eckert

HOCHDRUCK-DAMPF. Special Magazine Number of the Society of German Engineers. Size 9 by 11¾ inches. Pages, 108. Illustrations, 253. Berlin, S. W. 19, 1924. V. D. I. Verlag G. M. B. H.

This booklet embodies the proceedings of a meeting of the German Society of Engineers with a full text of the papers submitted and the discussion which followed. It contains also a reprint of various articles on allied subjects from the society's periodical, and some hitherto unpublished contributions relative to high pressure steam.

The following subjects are treated:

The efficiency and technical possibilities of superpressure steam; cost comparison.

Characteristics and use of superpressure steam in reciprocating engines and steam turbines; reheating cycle and regenerative feed heating; effect on various industries.

Power tests of an improved type of non-condensing turbine built by the Brünn Engine Building Works.

The auxiliary high pressure turbine as a means for improving the efficiency of existing plants.

The present status of operation with superheated steam; description and illustrations of reheat boilers built or building in various countries; the author's estimate of the Babcock & Wilcox reheat boiler.

Boiler building materials and modern types of boiler construction for high pressures.

New ways of conserving energy: heat reclamation.

Piping and fittings for steam pressures up to 100 atmospheres and 450 degrees C.; modern high pressure gate valves.

Below the title of each article is a summary of the subject matter treated and reference is made to detailed publications connected therewith; important deductions are in italics.

In addition to the intrinsic merits of the articles, the value of the publication lies in the fact that it combines the hitherto scattered information on the subject into one volume. From the nature of the purpose for which the book is intended it cannot be utilized for quick reference, but its perusal enables the reader to become familiar with the present tendencies and future possibilities of power plant engineering. It is interesting also to note that America has been given credit for pioneer work in this field, though it appears that Germany is lately making rapid strides and overcoming the handicap due to the war and the resulting economic conditions.

LETTERS TO THE EDITORS

Lifting Capacity of Floating Dry Docks

East Boston, Mass.

TO THE EDITORS:

In the August issue there is an account of a ship displacing 18,000 tons being lifted on a 10,000-ton floating dock. Although it may appear somewhat trite, I cannot refrain from pointing out the factors governing the lifting capacity of any floating dock and giving formulæ for computing this capacity.

The lifting capacity of any floating dock is directly proportional to the available freeboard and thus the available displacement. It corresponds exactly with the cargo carrying

American Firms Invited to Exhibit at
Next Shipping and Machinery
Exhibition in London

London, Eng.

TO THE EDITORS:

You may perhaps be aware that during the past twenty years there has been held at various intervals in London a series of Shipping, Engineering and Machinery Exhibitions at which the manufacturers of all nations have been represented, but although the largest exhibition building in England has always been secured it has been a matter of regret that the limitations of space have prevented adequate representation of America. This handicap, however, no longer exists, a 50 percent extension of the exhibition building known as "Olympia" having recently been made which

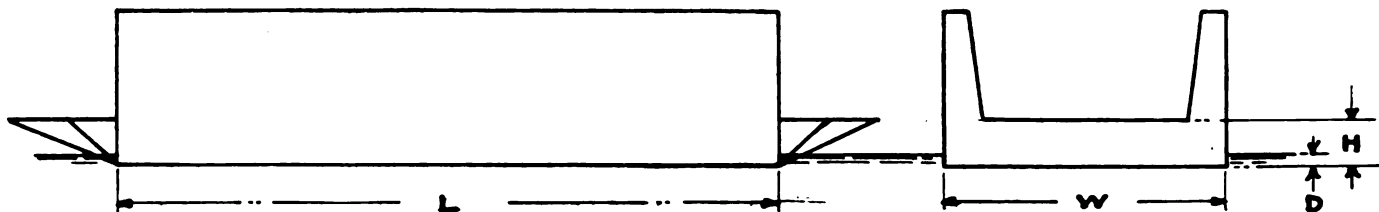


Diagram Showing Dimensions Used in Calculating Lifting Capacity of Floating Dry Dock

capacity or deadweight tonnage of any vessel, being the difference between the loaded and light displacements. The light displacement of a floating dock represents the weight of the dock structure and machinery plus the weight of the residual water which cannot be pumped out. The loaded displacement of a floating dock is that when the deck is level with the water and represents the weight of vessel lifted plus the weight of dock and residual water. The lifting capacity being the difference between these two it is a simple matter of calculation.

CALCULATION OF LIFTING CAPACITY

If L be the length of the floating dock pontoon, W the outside width, D the light draft and H the outside length of pontoon, then:

$$\begin{aligned}\text{Light displacement (long tons)} &= \frac{L \times W \times D}{35} * \\ \text{Loaded displacement (long tons)} &= \frac{L \times W \times H}{35} * \\ \text{Lifting capacity (long tons)} &= \frac{L \times W \times (H-D)}{35} *\end{aligned}$$

This might be called the normal lifting capacity. To bring the deck of the dock clear of the water no floating dock can lift a vessel weighing more than this formula will show. If a sectional dock is considered, the length L must be reduced by the total distances between the sections. If a steel dock with buoyant fantails is considered, this buoyancy must be added to the capacity.

By so loading a floating dock that its deck cannot be lifted clear of the water or by only partially lifting a loaded vessel a floating dock may lift more than its normal capacity due to the additional displacement of the wings but under such circumstances this additional weight lifted is only something over 30 percent of the normal lifting capacity.

I hope this will help put the discussion of floating dock capacity within the realm of reason.

J. STUART CRANDALL, C. E.,

Treasurer, The Crandal Engineering Company.

* Note: The divisor should be 36 for fresh water.

necessarily gives a very considerably increased area for the display of exhibits from other nations.

On the occasion of the last Shipping, Engineering and Machinery Exhibition, a banquet was given to overseas visitors, and in replying to the toast of "Our Visitors," Mr. Frederick D. Herbert, president of the Kearfott Engineering Company, Inc., New York City, expressed the hope that at the next exhibition an opportunity could be afforded to American firms engaged or connected with the shipping, shipbuilding, engineering and machinery industries to participate in what he described as "this magnificent exhibition" to a very much greater extent than hitherto, as he felt certain that this would benefit everyone concerned.

It has been arranged that the next exhibition shall be held from November 23 to December 5, 1925, under the presidency of the Hon. Sir Charles Parsons. The president, chairman and members of the Honorary Committee of Experts will be delighted to have a thoroughly representative display of the latest and most approved specialties on the American market, and have therefore decided to devote a certain portion of the building to an American section, which it is hoped may in every way eclipse the very fine Holland section at the 1919 exhibition. With a view to affording all possible information to firms interested in the project, I have arranged to spend some considerable time in the United States during the coming fall. I expect to reach New York about the middle of October, and if those of your readers who are interested in export trade, not only with the United Kingdom but with all other parts of the world (the Shipping Exhibition being attended by buyers from every part of the globe), will be good enough to send me a note to your care, I shall be delighted to furnish either personally or by mail all possible information on the subject.

In view of the wonderful co-operation which has been manifested in connection with the Advertising Convention and the visit of the legal profession, etc., the committee trusts that the same spirit of co-operation will be shown by American firms connected with the industries represented by the Shipping, Engineering and Machinery Exhibition, to the world-wide benefit of the interests of all.

F. W. BRIDGES,

General Manager, Shipping, Engineering and Machinery Exhibition,
London, Eng.

PERSONAL MENTION

J. F. PAGE, former operating manager of the Halifax Shipyards, has been appointed operating manager of the Gulf District for the United States Shipping Board.

L. E. ARCHER has been appointed Pacific Coast manager at San Francisco of the International Mercantile Marine Company, succeeding T. H. Larke, who has asked for retirement because of ill health.

R. R. ROW has been appointed director of sales for the several products manufactured by the Todd Shipyards Corporation known as the Todd Specialties. Mr. Row will make his headquarters at 25 Broadway, New York.

F. WARWICK, for a number of years marine superintendent of the Furness-Withy Steamship Company in New York, resigned recently and was succeeded by J. R. Holmes, formerly superintendent of Pier 38, South Wharves, one of the Furness branches.

L. E. GEER, vice-president and general manager of the Manitowoc Ship Building Corporation, Manitowoc, Wis., and president of the Manitowoc Portland Cement Company, a new interest, has transferred his headquarters from Manitowoc to Chicago, 908-910 Chamber of Commerce Building.

CAPTAIN ASA F. DAVISON, general manager of the marine department of the United Fruit Company, has become a member of the Steamship Owners' Association committee on the revision of navigation laws and rules, to fill the vacancy caused by the resignation of David T. Warden, formerly of the Tide Water Oil Company.

WILLIAM W. MILLS has been appointed Commissioner of Plant and Structures of the City of New York, succeeding Grover A. Whalen, resigned. Mr. Mills was for

four and one-half years first deputy commissioner in charge of municipal ferries which under his management increased from two to nine lines, the fleet growing from 9 to 28 ferryboats. He has under successful operation three new turbo-electric ferryboats and is building six steam driven oil burning ferryboats. Mr. Mills has given considerable study to the use of direct connected internal combustion engines for ferryboat propulsion and it is expected that in the near future this form



W. W. Mills

of power will be applied to reduce the cost of municipal ferry operation. He is also laying plans for the converting of coal burning vessels into oil burners.

CARL E. PETERSEN, former naval architect in charge of the United States Lines' technical department and recently associated with the United States Dredging Company as designing engineer at Galveston, has accepted the position of works manager for the Great Lakes Boatbuilding Corporation, Milwaukee, Wis.

G. C. KAHL, 404 Dwight Building, Kansas City, Mo., has been appointed sales representative of the De Laval Steam Turbine Company in Arkansas, Nebraska, Kansas and Oklahoma, Iowa west of the north and south line

through Des Moines but not including Des Moines, and Missouri west of and including Jefferson City.

LIEUTENANT-COMMANDER F. A. NICHOLS, purchasing agent of the United States Coast Guard, San Francisco, Cal., has been transferred from the California division to the Philadelphia navy yard, to become one of the officers of the U. S. S. *McCall*. He will be succeeded in San Francisco by Lieutenant-Commander C. C. McMillan, engineering officer.

GEORGE CLARKE, manager of the Kensington Shipyard Department of the William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa., was recently given a



George Clarke

testimonial dinner at the Philadelphia Yacht Club on the occasion of his twenty-fifth anniversary as manager of the yard. Mr. Clarke was born in Banffshire, Scotland, and has had a long and varied career in shipping and shipbuilding, his first experience having been gained as an apprentice with Smith & Rogers, engineers and shipbuilders, later known as London & Glasgow, Ltd. During the six years he spent with this company, he was given a very general training in all branches of the

industry with particular attention to engineering. After completing his apprenticeship, he went to sea in the employ of the African Royal Mail Steamship Company, of Liverpool, in whose vessels had been installed the first compound geared engines (operating with a boiler pressure of 34 pounds) ever built by Randolph & Elder of Glasgow. For six years he remained with this company attaining the rank of first assistant engineer on its largest vessels. In 1871 he engaged with the fleet of chartered vessels being operated by the American and Red Star Lines, which company was later known as the International Navigation Company. He remained at sea with this company about eight years and was in 1879 appointed to the position of assistant superintending engineer under the late James S. Doran, which position he retained until 1896. In this year he accepted the position of superintendent of construction with the Newport News Shipbuilding & Dry Dock Company and remained with that company for about five years. In the year 1900 he was appointed general manager of the Kensington shipyard department of the William Cramp & Sons Ship & Engine Building Company, in which position he is still active.

OBITUARY

FRANK C. OSBORN, a director and manager of the operating department of the Munson Steamship Lines and widely known among shipping men, died Saturday, August 16, in St. Peter's Hospital, Brooklyn.

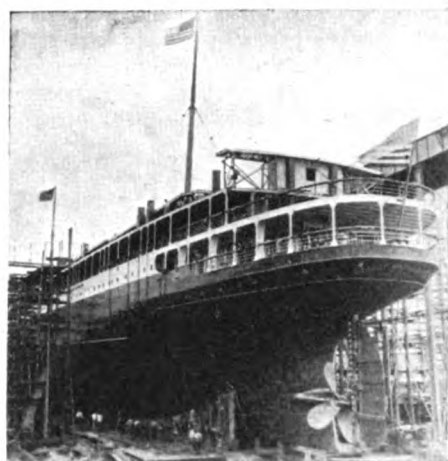
WALLACE DOWNEY, president of the Downey Shipbuilding Corporation, of Mariner's Harbor, Staten Island, N. Y., recently died in the Mountsinide Hospital, Montclair, N. J. Mr. Downey was born in Minudi, Nova Scotia, May 11, 1862, and had been engaged in the shipbuilding trade from his fourteenth year. He was credited with having originated the idea for standardized ships, and was one of the organizers of the Standard Shipbuilding Corporation.

The Month's Shipping and Shipbuilding News in Brief

Shipyard, Steamship and Port Activities and Other Notes
of Interest in All Branches of the Marine Industries

Old Dominion Steamship Launched at Newport News

THE new passenger and freight ship *George Washington* being built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for



Stern of the *George Washington*

the Old Dominion Line, was launched Wednesday, August 20.

This vessel is of the 3-deck, hurricane deck, coastwise type, 375 feet 6 inches in length by 53 feet beam and 29 feet 9 inches depth. Accommodations are to be provided for about 322 first class passengers, 58 steerage and 289 immigrants. The ship is about 2,100 deadweight tons carrying capacity.



Old Dominion Liner *George Washington* Immediately After Launching

Diesel Engine Plans for Government Vessel Conversion Program Completed, Builders to Submit Bids This Month

PLANS and specifications for the single acting Diesel engine types approved by the advisory committee to the Shipping Board, in connection with the Diesel conversion program, have been completed at the maintenance and repair office of the United States Shipping Board at 45 Broadway, New York, and submitted to the Diesel engine builders for consideration.

Six or eight manufacturers are being requested to bid on the Diesel engines and the board will give consideration to both single and double acting motors. The bids will be received before the end of September and the awards made shortly after that time.

HULL TYPES SELECTED

Captain Gatewood has announced that operators have requested the selection of 8,800 ton, 9,400 ton and 12,000 ton type ships for conversion. However, the board has decided that the 12,000 ton vessels will be reserved for future reconditioning. The ships to be converted are the 9,400 ton steamships built at the Oscar Daniel yard in Florida and the 8,800 ton ships built by the Los Angeles Shipbuilding Company. Installation of the engines will require about nine months. It is expected that the cost of

conversion will be about \$500,000 for each vessel, according to preliminary estimates.

The present plans and specifications are for the main engines only. After bids on these have been returned, examined, and specific engines definitely selected, further specifications will be prepared for the installation of the necessary auxiliaries.

PRIVATE CAPITAL INTERESTED IN DIESEL CONVERSION

The governmental interest in the conversion of surplus tonnage to Diesel drive has apparently aroused an increasing interest on the part of private enterprises in the possibility of purchasing hulls at a low figure for conversion to Diesel ships. Information that one such project is contemplated has been received at this office in which ten or twelve ships are to be involved.

Diesel Tug to Be Built for West Coast Service

A CONTRACT for the construction of a 125-horsepower Diesel tug has been awarded to the Crosby Marine Corporation, Lake Union, Wash., by the Tacoma Tug & Barge Company. The specifications for this vessel provide for the installation of a 125-horsepower Sumner semi-Diesel engine to be constructed by the H. W. Sumner Company of Seattle.

Fruit Line Still Plans Pacific Coast Service

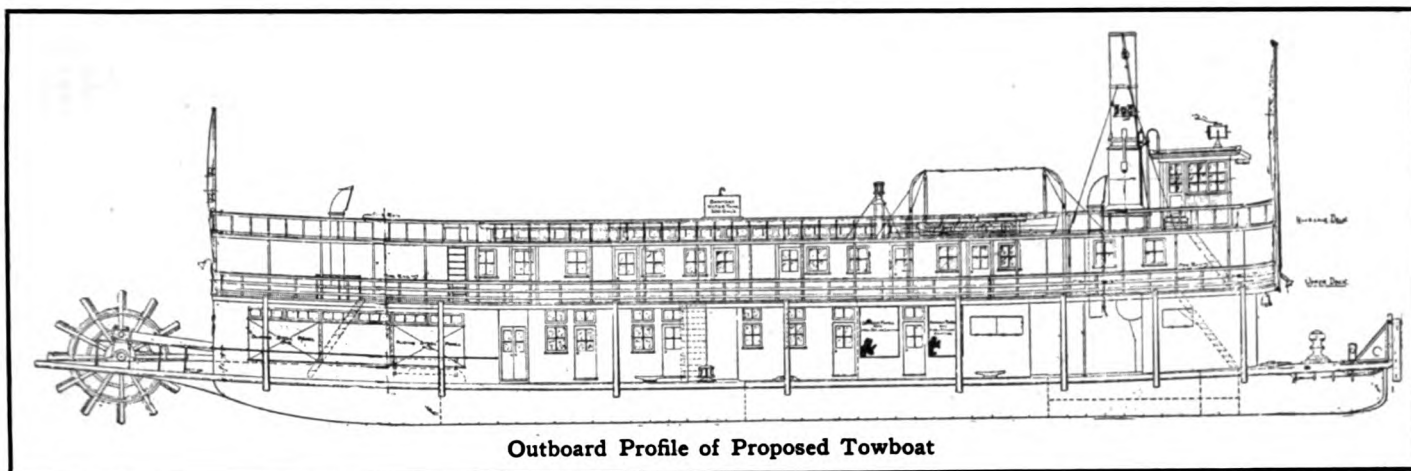
THE United Fruit Company, it was recently stated, has not abandoned its idea of running a service through the Panama Canal to the Pacific Coast, but is awaiting further developments as to the fruit crops to find out if there will be sufficient business to justify a new service.

New River Craft

Captain R. S. Oakes, Monongahela House, Pittsburgh, Pa., plans to build a landing boat 110 feet by 26 feet by 4 feet 6 inches, and a conveyor float 135 feet by 26 feet by 4 feet 6 inches. Contract for the lumber was awarded to Marsh & Truman Lumber Company, 3321 S. Michigan Ave., Chicago.

Freighter Planned

The Green Line, Pittsburgh, Pa., plans to build a new steel hull for use as a freight boat. Machinery from the *Greenwood* will be transferred to the boat.



Outboard Profile of Proposed Towboat

Bids Submitted for Stern Wheel Towboat

SEALED proposals were received and opened August 15, 1924, at the United States Engineer Office, Montgomery, Ala., for the construction and delivery of one steel hull, stern-wheel towboat.

The towboat will have an overall length of 153 feet 4½ inches; length, molded, 134 feet; breadth, molded, 30 feet; depth at side 4 feet 6 inches. She will be built with transverse watertight bulkheads and delivery is to be made at Apalachicola, Fla.

The tenders submitted were as follows:

Charleston Drydock & Machine Company, Charleston, S. C.	\$130,765
Howard Shipyard & Dock Company, Jefferson, Ind.	167,743
Charles Ward Engineering Works, Charleston, W. Va.	169,200
Dravo Contracting Company, Pittsburgh, Pa.	182,000

ENGINES AND BOILER

Propulsion will be by engines of the high pressure simple type, with cranks of the wheel shaft set at 90 degrees. They are to be constructed for a working pressure of 250 pounds of steam, with 150 degrees of superheat. The cylinders are to be 13 inches in diameter with a stroke of 60 inches. Steam is to be supplied by one watertube boiler of the cross drum type with a heating surface of approximately 1,570 square feet and fitted for burning bituminous coal. The boiler tubes are to be two inches in diameter of simplex steel and the boiler is to be fitted with soot blowers equal to those manufactured by the Diamond Power Specialty Company of Detroit. An auxiliary boiler of sufficient capacity to furnish steam for heating the vessel and heating water for washing purposes is to be installed. It is to carry 25 pounds pressure per square inch and will be fitted for burning coal.

EQUIPMENT

Included in the engine room equipment to be installed are the following:

Two vertical simplex feed pumps 6 by 4 by 12 inches, Bethlehem-Weir, Davidson, or equal; a double tube feed water injector of sufficient capacity for supplying the maximum amount of feed water is to be of Schoette & Koerting make, or equal; an 8 by 10 by 12-inch vertical or horizontal simplex fire and bilge pump, Davidson, Bethlehem-Weir, or equal; a feed water, single pass, steel shell heater of the Row & Davis type, capable of raising the temperature of feed water from 100 degrees to 212 degrees with five pounds of exhaust steam; a vertical pressure filter equal to that manufactured by

the International Filter Company, Chicago, having a capacity of 1,270 gallons per hour; a complete fresh water still of the Row & Davis type, having a capacity of 200 gallons of distilled water per twenty-four hours. All valves to steam or feed lines or valves that are subject to high pressure, shall be Lukenheimer, Crane, or equal.

The paddle wheel is to be radial fixed paddle type 15 feet in diameter over buckets, with 12 buckets 24 inches wide by 20 feet 6 inches long.

A motor driven exhaust ventilation system is to be installed in addition to a motor driven refrigerating machine of one-half ton capacity, similar to that manufactured by the Johns Manville Company, or the C O No. 2 type, as manufactured by the York Manufacturing Company.

One steam driven, double barrel, reversing capstan with double cylinders 5 by 7-inch engines and two steam driven non-reversing gypsy capstans, with double 4 by 6-inch cylinder engines are to be installed on the boat. The vessel will be heated by a complete system of heating by means of low pressure steam.

The steamer will be electrically lighted and there is to be installed one 6-kilowatt,

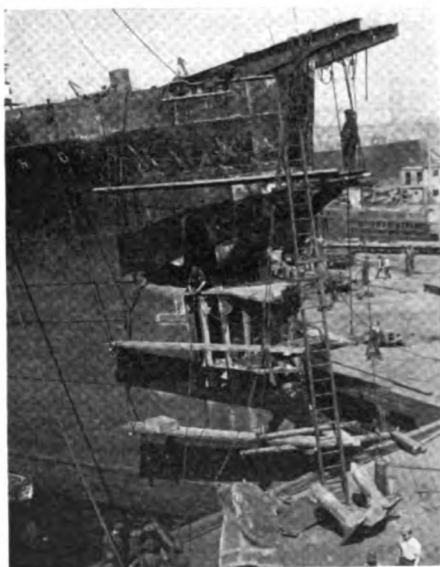
110 volt direct current gasoline or kerosene engine-driven electric generator, similar to model 2-C-6 unit of the Landstadt-Meyer Company of Appleton, Wis.

Tietjen & Lang and Robins Yards Repairing Boston and Swift Arrow

THE Tietjen & Lang yard, Hoboken, New Jersey, of the Todd Shipyards Corporation, has been awarded the contract for reconditioning the Eastern Steamship Company's passenger steamer *Boston*, at a price of \$129,600 and 38 days' time, as a result of bids opened on Thursday, July 24. The work includes extensive engine room and machinery repairs, in addition to the reconditioning of staterooms and the ship's hull, as a result of damage sustained in collision with the tanker *Swift Arrow*.

SWIFT ARROW CONTRACT

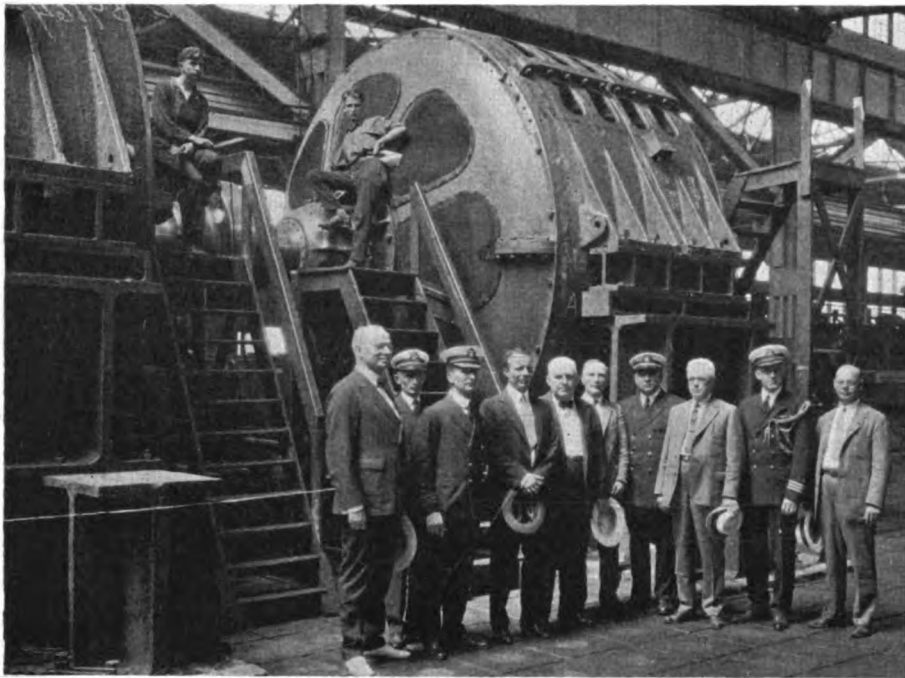
For repairing the damaged tanker *Swift Arrow*, of the C. D. Mallory Company, the Robins yard of the Todd Shipyards Corporation has been awarded the contract on a bid of \$13,875 and 12 days' time.



S. S. Swift Arrow at Robins Plant of Todd Shipyards Corporation After Collision with S. S. Boston off Point Judith on July 21



Damage to the Eastern Steamship Company's Passenger Steamship Boston by Collision in Fog with S. S. Swift Arrow



Assistant Secretary of the Navy Theodore Roosevelt Inspects 22,500 Horsepower Motors for U. S. N. Airplane Carriers Lexington and Saratoga at Schenectady Works of the General Electric Company

Left to right: Rear Admiral J. K. Robison, Chief of Bureau of Engineering, U. S. N.; Lieut. G. L. Harriss; Commander J. S. Evans; Assistant Secretary Theodore Roosevelt; Superintendent J. A. Smith of the Schenectady Works; D. W. Niven, Manager Marine Sales Department, G-E Company; Chief Electrician Zehner; Maxwell W. Day, Engineer Marine Department, G-E Company; Commander R. L. Ghormley, Aide to Secretary Roosevelt; B. P. Lamberton, Washington Office of G-E Company.

Assistant Secretary Roosevelt Inspects Naval Machinery at General Electric Works

ASSISTANT Secretary of the Navy Theodore Roosevelt visited the Schenectady works of the General Electric Company on August 6 and inspected the equipment which is being made there for the two airplane carriers, *Lexington* and *Saratoga*, which includes motors, turbines, control equipment, auxiliary apparatus and radio equipment.

Each of the motors for the airplane carriers has a capacity of 22,500 horsepower,

and measures 15 feet in diameter. They will be connected in pairs to each of the four propellers and will deliver 45,000 horsepower to each, or 180,000 horsepower to all of them. This is the greatest horsepower per shaft that has ever been projected in any marine installation, irrespective of the type of motive power. The turbine generators for the ships are rated at 40,000 kv-a., 5,000 volts each. Four units will be installed in each vessel. The turbines will be operated by steam from 16 oil-fired boilers.

The two ships are expected to be capable of making more than 33 knots, or 12.6 knots faster than the battleship *Maryland*. This will place them among the world's speediest vessels.

Plans and Specifications Being Prepared for Two New Seagoing Diesel Yachts to Cost \$375,000

DETAILS for two new seagoing Diesel yachts are now being prepared by J. H. Wells, naval architect of New York City. It is understood that the plans and specifications will be completed and sent out to builders for bids in about six weeks' time.

DETAILS OF YACHTS

One of these yachts will be 125 feet overall, length; 22 feet, beam; 7½ feet, draft driven by two 300-horsepower Diesel engines at a speed of 16 or 17 knots and will cost approximately \$200,000. This yacht will be of the raised deck torpedo-boat destroyer type, with two deckhouses, a large flying bridge, twin stacks and one mast. Accom-

modations will include six staterooms with three baths in the owner's quarters and the yacht will carry a crew of ten men.

The second yacht to cost approximately \$175,000, is to be 115 feet overall, length; 20 feet, beam; 7 feet, draft, of a powerful seagoing type. She will have a plumb stem, steamer stern, a high raised forecastle, two deckhouses and a pilot house, with a summer deck on top of the pilot house. This craft will be powered with two 200-horsepower Diesel engines, which will give her a speed of about 13 knots. The yacht will be fitted with five staterooms and three baths in the owner's quarters. She will carry a crew of ten men.

Both yachts will carry large fuel and water supplies for extended cruises.

Official Trial of the M. S. Henry Ford II

AN event which has been awaited with much interest by shipping people, particularly on the Great Lakes, took place on Thursday, August 14, when the motorship *Henry Ford II*, built by the American Shipbuilding Company at its Lorain, O., yard was given her official trial trip.

This great vessel is remarkable, not only in that she is the first large vessel to be fitted with Diesel propelling machinery on the Great Lakes, but also from the fact that she is undoubtedly the most elaborately and expensively outfitted and equipped cargo vessel that has ever been constructed.

The general design of the ship does not vary materially from the ordinary lake ore carrier, the most noticeable feature of the hull construction being the adoption of longitudinal framing for the bottom and decks and transverse for the sides and ends. This system has, however, been followed in other recently built lake ships.

It is in the finish and fittings of the quarters and in the general equipment of the vessel that the *Ford* is quite in a class by herself. The woodwork in the owner's quarters is equal to that on the finest yachts and baths, toilets and similar fittings are on a scale to be found only in the most modern and expensive hotels. The floor and sides of all baths and toilets, crew's as well as owner's, are completely tiled, and the fact that the shower bath screens in the crew's quarters are of heavy plate glass, and that all fittings, of every description are nickel plated, gives a little idea of the elaborate and unusual manner in which the quarters are fitted up.

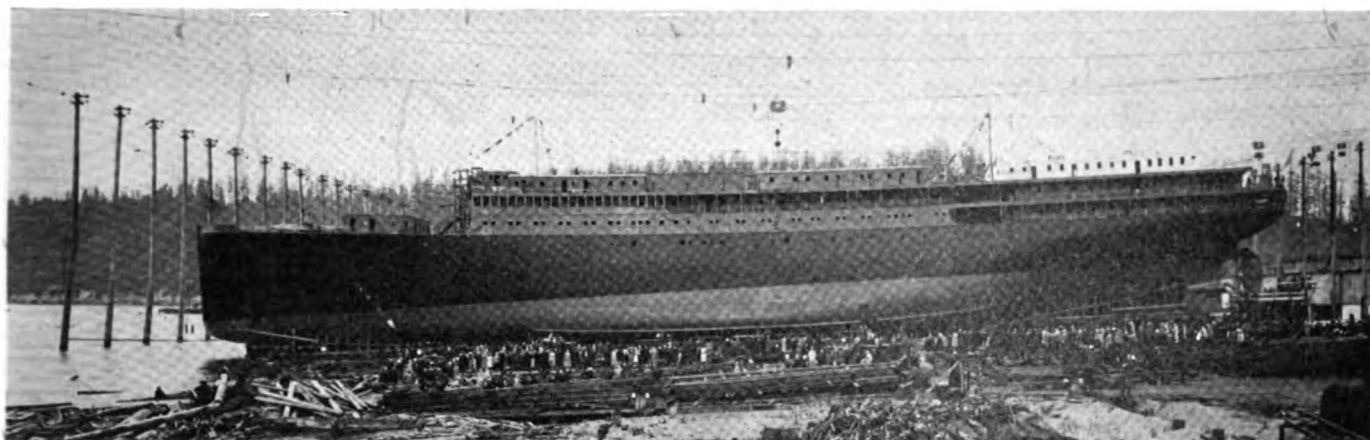
The adoption of Diesel propelling machinery has been accompanied by the use throughout the ship, of electric-power for all purposes, including heating and cooking. An electric sign "Ford" appears on either side of the funnel, certainly a novelty in cargo vessels.

The navigating equipment is most unusual for a lake ship and includes gyroscopic compass, recording speed indicator, recording sounding machine and radio direction indicator.

The operation of all the machinery during the trial trip was without a hitch. The main engines, of the Sun-Doxford type (illustrated in our June issue) ran with exceptional smoothness. No attempt was made at high speed, the revolutions being purposely kept down to a maximum of 65 to 68 a minute.

The trial was attended by leading officials of the ship and engine builders, as well as a large number of shipowners and operators and marine engineers from the Great Lakes district and several from Atlantic coast ports. All were enthusiastic in their praise of the smooth operation of the vessel, and the particularly fine piece of work turned out by the shipbuilders, the engineers and all others concerned in the construction of the vessel. It appeared however, to be a general opinion among the guests that only the unusual financial resources of the Ford Company made the construction of such a vessel possible and that for an ordinary commercial venture the initial cost of the elaborate fittings and details, as well as the undoubted high cost of upkeep resulting from them, were quite out of the question.

After landing the trial guests at Lorain, the ship proceeded to Toledo to take on her first cargo of coal for the upper lakes.



Launching of Passenger Steamship *Bienville* from the Tacoma, Wash., Yard of the Todd Shipyards Corporation

Southern Pacific Liner Launched at Tacoma

THE steamship *Bienville*, which is being built by the Todd Dry Dock & Construction Corporation for service between New York and New Orleans in the Southern Pacific Company, Atlantic Steamship Lines' fleet, was launched at Tacoma, Wash., last month and will be delivered in New York in time to participate in the rapidly increasing water and rail winter tourist traffic to California via the Sunset route.

The *Bienville* is a single screw steamer, 445 feet long overall, 428 feet length between perpendiculars, 57 feet beam, 37 feet 6 inches depth to hurricane deck, with a load draft of 25 feet 6 inches and a deadweight capacity at that draft of about 7,000 tons. Her shaft horsepower is 7,100 and at 85 revolutions per minute she will have a sea speed of 16 knots.

The hull is built of steel on the Isherwood system with a complete double bottom, 3 complete steel decks—the hurricane, main and lower—and a steel orlop deck in No. 1 hold. Above the hurricane deck are the promenade and boat decks. Seven watertight bulkheads subdivide the ship into eight watertight compartments.

Oil fuel is carried in two deep tanks extending from the lower deck to the shell. Forward and aft of the boiler room each tank is subdivided into three tanks.

There are twenty hinged cargo ports in the shell for access to the lower and main 'tween decks and hatches to each hold are provided for the rapid handling of cargo.

The first class passengers are accommodated in rooms above the hurricane deck amidships. The third class passengers are carried in six-berth rooms on the main deck forward. The deck crew is housed in the winch house on the hurricane deck forward and the officers in a house on the boat deck.

On the main deck forward of the boiler casing are the ship refrigerator rooms and galley, the galley stores and linen lockers are on the starboard side of the boiler casing and the bakery, bakery stores and firemen's mess on the port side of the casing. Between the engine and boiler casings are the refrigerating machinery, the engineers' workshop, foamite tank room and cook's and firemen's toilets. Aft of the engine room on the main deck is a large baggage room and further aft are the stewards' quarters, steering gear and carpenter shop.

The main dining room, with a seating capacity for 200 at small tables, is located in the forward end of the superstructure. A music room is fitted in the forward end of the promenade deck house and the smoking

Fore River Plant to Recondition Argentine Naval Ships *Rivadavia* and *Moreno*; Bids Received for Tanker

ONE of the largest individual contracts of the year thus far awarded, was announced last month in the placing with the Bethlehem Shipbuilding Corporation, Fore River Plant, of the work of overhauling and reconditioning the Argentine battle-ships *Rivadavia* and *Moreno*, involving, according to unofficial estimates, a total expenditure of approximately \$8,000,000. The *Rivadavia* is scheduled to arrive at the Fore River plant about September 1, and there will be about a year's work on each ship.

Among the principal items involved in the reconditioning are the installation of reduction gears; conversion from coal to oil burning; installation of a new fire control system, new wireless and new search-light systems; new triple mast aft, and various other items of modernization. While the work will be under the general supervision of

room and lounge are in a separate house on the boat deck.

The propelling machinery consists of De Laval turbines and double reduction gears, steam being supplied by six Babcock & Wilcox oil-fired watertube boilers.

Rear Admiral J. Irizar, head of the Argentine Naval Commission in New York City, he will be represented at the shipyard by E. Ciarlo, who will supervise the work at Fore River on behalf of the Commission.

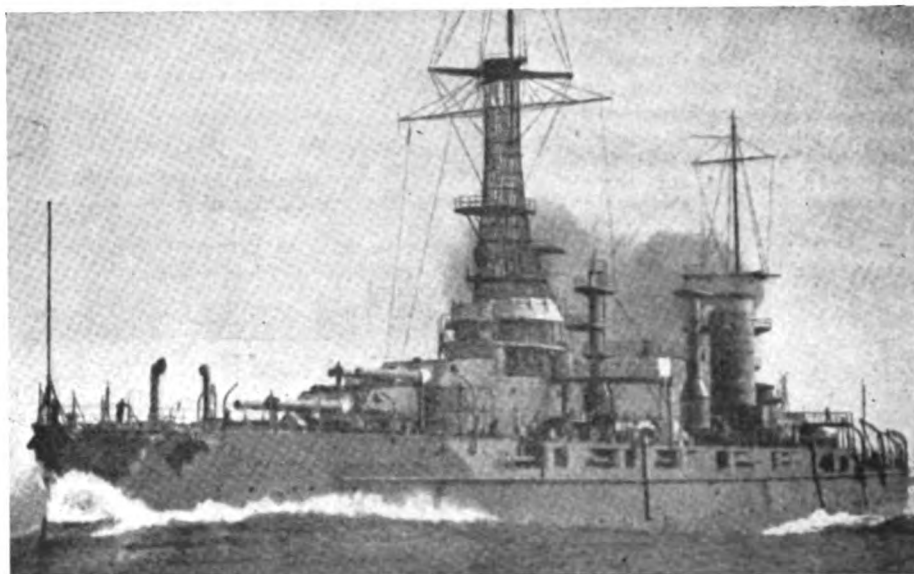
DIMENSIONS OF SHIPS

The *Rivadavia* and *Moreno* are sister ships, the former having been completed by the Bethlehem Company in 1914, and the latter by the New York Shipbuilding Corporation in 1915.

The *Rivadavia* was launched at Quincy, Mass., on May 26, 1911, and has a length overall of 594 feet 9¼ inches; beam, molded, 98 feet; depth, molded, 42 feet, with a displacement of 27,566 tons. She is equipped with Curtis turbines developing 39,000 shaft horsepower, driving the vessel at a speed of 22.5 knots. Steam is supplied by eighteen Babcock & Wilcox boilers, the engines turning triple screws. Each ship cost over ten and one-half million dollars to build.

TANKER BIDS RECEIVED

The Argentine Naval Commission has also issued plans and specifications for the con-



Argentine Battleship *Rivadavia*, Sister Ship of the *Moreno*, Both of Which Are to Be Reconditioned

struction of a 10,000-ton tanker for which proposals were received by Admiral Iricar on August 11. Although it was at first reported that prices were to be asked for turbine and Diesel propulsion, it was stated that reciprocating engines would be installed, capable of driving the vessels at a speed of 12 knots.

Conversion of Steel Scow to Quarterboat Awarded American Car

THE contract for the conversion of a steel scow into a quarterboat for the United States Engineers Office, Philadelphia, Pa., has been awarded the American Car and Foundry Company of Wilmington, Delaware, at a price of \$18,108. Tenders were received on July 25 with the following results:

Howard E. Wheeler, Brooklyn, N. Y....	\$16,835
American Car & Foundry Company, Wil- mington, Del.	18,108
William Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa.	20,300
Bethlehem Shipbuilding Corporation, Phila- delphia, Pa.	21,396
New York Shipbuilding Corporation, Cam- den, N. J.	24,650
Sun Shipbuilding & Drydock Company, Chester, Pa.	26,759

Bids Submitted for Electric Drive Conversion of Standard Oil Tanker

THE bids received recently on the West Coast for the conversion of the Standard Oil Company's tanker *K. R. Kingsbury* to an electric drive ship, were as follows:

Los Angeles Shipbuilding & Drydocking Company	\$199,999 and 99 days
Bethlehem Shipbuilding Corporation	238,297 and 90 days
Newport News Ship- building Company ..	256,000 and 130 days
Moore Drydocking Company	257,000 and 110 days
Sun Shipbuilding Com- pany	358,000 and 120 days
Todd Drydock & Ship- building Company ...	448,000 and 120 days

Bids Received for Three Dipper Dredges

BIDS were received and opened by the United States Engineer Office, Louisville, Ky., August 18, 1924, for the construction and delivery of three dipper dredges, one without machinery for Nashville Engineer district for use on the Cumberland River, delivery to be made at Paducah, Ky., and two dredges with all machinery for Louisville Engineer district with delivery at Louisville. They were classified as follows: Lot A, one dipper dredge complete, ready for service; Lot B, two dredges complete, ready for service; Lot C, one dredge less machinery and equipment; Lot D, one dredge with and one dredge without machinery; Lot E, two dredges complete and one dredge without machinery. Tenders submitted were as follows:

LOT A		LOT B		LOT C	
Dubuque Boat & Boiler Works....	\$247,000—575 days	\$487,000—575 to 600 days	\$165,000—575 days		
Charles Ward Engineering.....	269,000—365 days	512,300—365 to 420 days	185,000—200 days		
Dravo Contracting Company.....	229,100—255 days	426,500—250 to 285 days	161,500—255 days		
LOT D		LOT E			
Dubuque Boat & Boiler Works....	\$412,000—575 days each	\$ (no bid)			
Charles Ward Engineering.....	447,000—365 days and 200 days	689,000—365 to 420 days and 200 days			
Dravo Contracting Company.....	364,500—285 to 255 days	557,000—285 to 315 days and 255 days			

Tenth Anniversary of the Sperry Gyro-Compass School

THE Sperry Gyro-Compass School has just celebrated its Tenth Anniversary. Instituted in the summer of 1914, this school has never had an idle day. The first four years of the school were devoted entirely to the instruction of United States and Foreign naval personnel, as the output of Sperry gyro-compasses was confined to naval use. The importance of having trained personnel in the Navy on gyro-compasses prompted the Government to combine the gyro-compass course given by the Sperry



Sperry Gyro-Compass School

school in their electrical schools at Hampton Roads. This allowed the school at the Sperry plant to devote the time to the merchant service personnel, as gyro-compasses were then available for merchant ships.

The school has grown to a point where about 75 men and officers per month receive instructions. Due to the fact that some of the personnel have only several days while their ship is in port, the course is so arranged that they can continue the course from time to time, and finally pass an examination and receive a certificate.

This school has also been expanded to include instructions on the high intensity searchlight and the gyro-pilot, familiarly known to seamen as "Metal Mike," and other Sperry navigational equipment.

Inasmuch as the gyro-compass and gyro-pilot have become so universally used, it has been necessary for the Sperry school to open branches in Los Angeles, San Francisco, Seattle, Cleveland and Liverpool. The Sperry school has been in operation in London for a great number of years.

The course includes the theory of the gyroscope and the gyro-compass, assembly and disassembly, care, maintenance and operation, and finally the use of the compass in true north navigation.

Boat Yard Expansion

The A. W. de Young Boat & Ship Building Company of Alameda, has announced plans for incorporating for \$150,000, to ex-

pand their present yards, as a result of various shipbuilding contracts recently received. A 100-foot frontage on the Oakland side has been leased by the company and two new buildings will soon be completed.

Contract Awarded for Construction of Diesel Driven Yacht

A CONTRACT for the construction of a steel Diesel-driven yacht for Walter O. Briggs of Detroit, Michigan, has been awarded the Consolidated Shipbuilding Corporation of Morris Heights, New York. The vessel was designed by J. H. Wells, naval architect of New York City and will have an overall length of 118 feet 7 inches; 110 feet 2 inches on the waterline; beam 21 feet 5 inches, and draft 7 feet. Power will be supplied by two Winton Diesel engines with a bore of 9½ inches and stroke of 14 inches, each engine having six cylinders and being rated at 180 horsepower.

The vessel will be of the flush deck type, with two main deckhouses and will be equipped with all modern electrically driven auxiliaries. She will carry a complement of twelve officers and crew. The fuel and water tanks will be built into the vessel. There will be two masts and one funnel, her life-saving equipment including two launches and one dinghy. It is understood that the contract will involve an expenditure of close to \$200,000.

Bethlehem to Get Half Million Dollar Tanker Conversion Job

THE General Petroleum Company, of San Francisco, Cal., has purchased the tanker *Lio* from the Shipping Board and is negotiating with the Bethlehem Shipbuilding Corporation for conversion of the ship to Diesel propulsion. The *Lio* is a vessel of 10,250 gross tons and present plans provide for the installation of a Bethlehem Diesel engine of 2,800 brake horsepower. It is believed the work necessitated by the reconditioning will cost close to \$500,000.

Prometheus Contract Goes to Krupp Works

THE contract for the reconditioning of the motor tanker *Prometheus*, has been awarded to the Fried. Krupp Germania-werft, Germany, by the Standard Oil Company of New Jersey. The price at which the work will be done could not be obtained. The date of delivery for the ship is fixed at four months.

The *Prometheus*, a motorship of 8,950 gross tons, was recently badly damaged by fire, necessitating a complete reconditioning.

Steamboat Hull Awarded

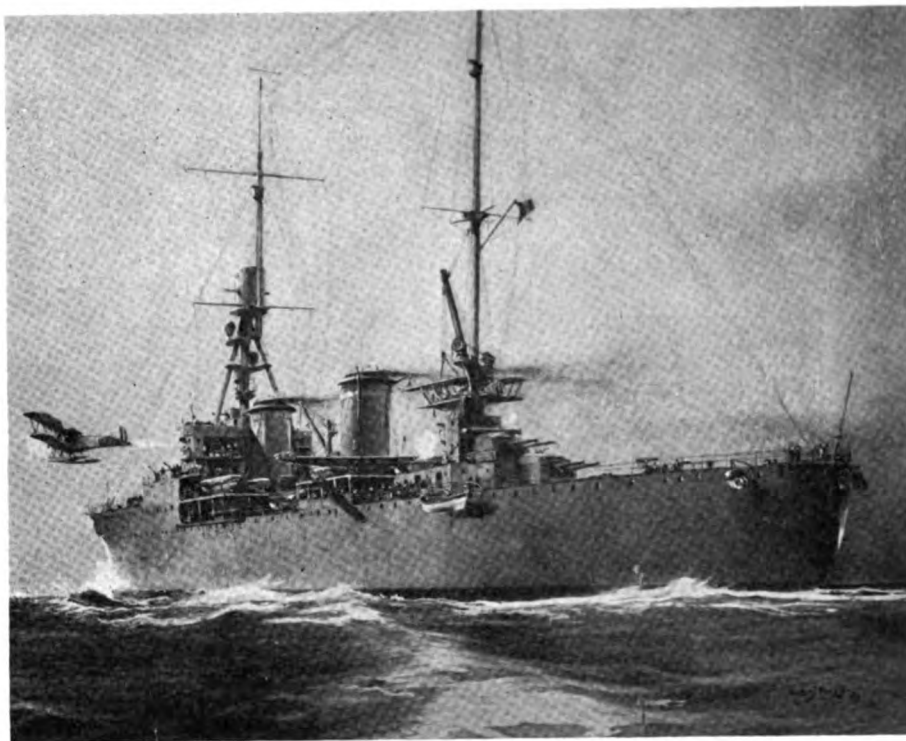
A contract for the construction and delivery of one steel steamboat hull for U. S. S. *Colbert* has been awarded to the Nashville Bridge Company, Foot of Shelby Ave., Nashville, by the United States Engineer's Office, Nashville, at \$26,490.

More Foreign Orders for French Shipyards

By Our Paris Correspondent

I ALLUDED in several issues of this year to the important orders which have recently been placed by foreign firms with French shipbuilders, such contracts being favored to a certain extent by the depreciation of the French currency on the world's market. It is interesting to note that several developments of interest have just taken place in that respect: the Latvian Government placed in July with the Chantiers de la Loire and the Chantiers Augustin Normand an order for two minesweepers and two submarines.

On the other hand, the Standard Oil Company contracted in July with the Chantiers et Ateliers de la Gironde for the construction of a motor tanker of 10,000 tons displacement which will be utilized for the transport of lubricating oils. The vessel will be 122 meters long and 16.90 meters beam; she shall be built on the Isherwood system. The tanks will be cylindrical, and the propelling machinery will consist of one two-cycle 1,900 horsepower Sulzer engine. The vessel will be constructed at the Bordeaux yards of the above firm.



By courtesy of "L'Illustration"

The New French 10,000-Ton Cruisers as They Will Appear When Completed

Sonic Depth Sounder Demonstrated to Marine Writers on Ocean Trip

A PARTY representing the marine news writers of New York city was given a most instructive and pleasurable trip last month, as guests of the Submarine Signal Corporation, of Boston, Mass.

Proceeding to Baltimore by train, the party embarked on the S. S. *Berkshire* of the Merchants & Miners Transportation Company for the trip to Boston, via Newport News and Norfolk.

FATHOMETER INSTALLED ON THE BERKSHIRE

The *Berkshire* is equipped with a fathometer, or sonic depth sounder, developed by the Boston company, and it was with a view to giving the newspaper men an opportunity of seeing this novel and, quite probably, epochal piece of apparatus in practical operation, that the trip was undertaken.

Upon arrival at Boston, the party was taken to the Lenox Hotel as guests of the Submarine Signal Corporation and on the following day, after being treated to a shore dinner at the Pemberton Inn, returned to New York by train.

DETAILS TO BE PUBLISHED LATER

The fathometer marks an important step in the development of the art of navigation and we expect to give a full description of the principle upon which it works, together with some actual depth records, obtained by its use, in a later issue.

New Tug Contract Goes to Abbott Shipyard

A contract for the first wooden tug to be built on the Delaware River in many years has been awarded to the Abbott's Shipyard of Delaware. The new tug will have a length of 95 feet; beam 23½ feet; depth 13 feet. She will be equipped with 600 horsepower engines. The tug is being built for Frank Moran and will be used for general harbor work in New York and vicinity.

Shipping Board Orders Bronze Propeller Blades

A LARGE contract for propeller blades has just been awarded the American Manganese Bronze Company, of Philadelphia, Pa., by the United States Shipping Board. The contract is probably the largest one that has ever been placed for bronze blades. It is estimated that it will considerably exceed half a million pounds of machined manganese bronze castings, the average weight of which is about 4,000 pounds each.

The new propellers are for ships operated or controlled by the Shipping Board. It is anticipated that during the term of this contract a large number of these vessels will have installed new Diesel engines in place of steam machinery, a change which incidentally will make for marked economy in operation but will necessitate in most every case a new design of propeller.

Shipyards and Drydocks

The insular government of San Juan, Porto Rico, has granted Felix Benitez Rexach forty acres on an island in the harbor for the development of a drydock for ships of 20,000 tons capacity, and the largest ship repair yards in the West Indies. Approximately \$5,000,000 will be spent on the project, which will make this the best equipped port between New York and the Canal Zone.

NEW DRY DOCK PLANNED

Plans are being prepared for the construction of a new drydock at Kingston, Ont., with four times the capacity of the present drydock and to cost approximately \$4,000,000. The new dock will be 300 feet wide and 700 feet long and will be able to accommodate two of the largest lake vessels at one time.

The New French 10,000-Ton Cruisers

THE French post-war naval programme, which was ratified by Parliament in April 1922, provided for the construction of three 8,000-ton cruisers, 6 destroyers, 12 torpedo-boats and 12 submarines. All these warships are to be completed in 1925.

In addition to that first stage of the post-war naval programme the French Parliament authorized in April last the Minister of Navy to lay the keels of two 10,000-ton cruisers, six 1,450-ton torpedo-boats, and two 1,500-ton submarines.

A sketch showing one of the 8,000-ton cruisers above referred to as they will appear when completed appeared in the January issue. We are now publishing in this issue a sketch showing one of the two 10,000-ton cruisers, the construction of which has just been commenced by the naval dockyards of Brest and Lorient. These cruisers are to be named respectively *Cassard* and *Bouvet*. They shall be 185 meters long, 19 meters beam, with a draught of 5.85 meters. The propelling machinery will consist of four Parsons turbines developing a total of 120,000 horsepower. The service speed will be about 34 knots. The boilers will be oil-fired. These cruisers will be armed with eight 203 millimeter guns, eight 75 millimeter anti-aircraft guns, eight 40 millimeter guns and two triple torpedo tubes 550 millimeters in diameter.

Diesel Engine for New Vessel

The hull of the *James Rolph III*, the last vessel built at the Eureka shipyards of Mayor Rolph, San Francisco, Calif., is to have a Diesel engine installed in the near future. The *James Rolph III* is 255 feet long, with a beam of 45 feet and a depth of 17 feet. The new vessel will be operated by the owner, and will probably be used in the lumber trade.

Herreshoff Boat Building Plant Auctioned

THE famous Herreshoff boat building plant at Bristol, where every defender of the America's Cup has been designed and constructed since 1893, was put on the auction block at a voluntary liquidation sale commencing at 10 o'clock on Thursday, August 21. The yards with full equipment were to be sold as a whole or in seven parcels.

New London Plant Resumes Building Operations

On July 30, the officials of the New London Ship & Engine Company which is building submarines for the United States Government, ordered four hundred men back to work. They were laid off six weeks ago, because, it was alleged, the Government was negligent in settling its bills for the boats under construction. Now, according to President Spear, of the company, the Government has agreed to make payment and the construction of the submarines will be continued.

New Incorporations

With a capitalization of \$300,000 in preferred stock and 60,000 shares of no par value common stock, the New England Maritime Company has been incorporated under the State of Maine laws to build, repair, charter and operate vessels.

The Waterway Navigation Company of Manhattan, has been chartered under New York laws with a capitalization of \$10,000. F. J. and J. B. Parks and E. F. C. Parker.

The Kingston Shipbuilding Company, Kingston, Ont., has been incorporated to operate ship building plants and to build ships and boats. The authorized capital is \$1,300,000. William S. Morlock, Sidney E. Wedd, Bruce V. McCrimmon, and others, all of Toronto, are the organizers and incorporators.

With a capitalization of \$400,000, the Panama-Ecuadorian Steamship Line was recently chartered under Delaware laws.

The Los Angeles Terminal Company of Wilmington, has been incorporated under Delaware laws with a capitalization of \$1,500,000, to handle the docking of vessels.

The Seaboard Terminals Corporation has been incorporated under Maryland laws with a capitalization of \$1,000,000 and has taken a ninety-nine year lease on a large tract on the Baltimore waterfront where the company plans to build an oil refinery and loading plant and to engage in wharfage and berthing of oceangoing ships.

The American Palestine Line of Manhattan has been chartered under New York laws with a capitalization of \$175,000 to engage in transportation. W. Gordon, R. Glick and J. W. Cottlieb are the incorporators.

The New York, Raritan Canal & Philadelphia Steamboat Company of Manhattan has been chartered at Albany with a capitalization of \$5,000 by C. L. Fuller, J. H. Finkler and R. Greenbaum.

The Kingston Shipbuilding Company of Kingston, Ont., has been chartered with a capitalization of \$1,300,000. The head office of the company and its plant will be located in Kingston.

Trade Publication

BETTER LUBRICATION.—The McCord Radiator & Manufacturing Company, Lubricator Division, 2587 East Grand Boulevard, Detroit, Mich., in a new catalogue points out the phases of economy that can be obtained from proper and efficient lubrication. The catalogue contains a complete set of overall dimensions, price lists, descriptions and illustrations of the class B lubricator adapted to small steam engines, oil engines, gasoline engines, air compressors, steam pumps and auxiliaries.

Business Notes

Connar C. Engstrand of the firm of Armstrong and Engstrand, 26 Water Street, New York, has been awarded patents by the Patent Office to cover trapezoidal pontoon drydocks, which construction it is claimed will materially reduce the cost of building drydocks. It is also said to reduce dredging and pier work and space required.

The Southern Steamship Company of Houston announces the appointment of F. M. Johnson from manager of the local offices to vice-president of the company. T. B. Bartle has been appointed commercial agent and D. D. Karn has been promoted to dock agent of the same company.

The Chicago Pneumatic Tool Company announces the transfer of Ross Watson, formerly district manager of the Cleveland Branch Office of this company to the district managership of the Minneapolis Branch to succeed D. M. Westbrook, now general manager of the Canadian Pneumatic Tool Company. Other recent changes include the transfer of L. J. Westenhaver, from the Pittsburgh Office to Cleveland, as district manager of the branch, and E. C. Stroup, compressor engineer in the Boston territory, to the Pittsburgh District.

The A. K. Miller Engineering Company, 1027 Annunciation Street, New Orleans, marine representatives for the Gulf District of the Power Specialty Company and Foster Marine Boiler Corporation has opened a branch office in Mobile, Alabama. The new office and warehouse is located at No. 4 North Water Street and will cover all ports on the Gulf between Pensacola, Florida and Gulfport, Mississippi. C. V. Fanning has been appointed manager of this district for the A. K. Miller Engineering Company.

MARINE SOCIETIES

AMERICA

American Society of Naval Engineers
Navy Department, Washington, D. C.

Secretary-Treasurer—Commander Bryson Bruce, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.

Society of Naval Architects and Marine Engineers

29 West 39th Street, New York
Secretary and Treasurer—Daniel H. Cox.

National Association of Engine and Boat Manufacturers

29 West 39th Street, New York City
Secretary—R. R. A. Hand.

United States Naval Institute
Naval Academy, Annapolis, Md.

Secretary and Treasurer—Commander H. K. Hewitt, U. S. N.

American Marine Association

15 Park Row, New York
President—Frank J. Shipman.

The New York Tow Boat Exchange

11 Moore St., New York.
Secretary—Irrving G. Keller.

Port of New York Authority

11 Broadway, New York
Chairman—E. H. Outerbridge.
Secretary—William Leary.

National Association of Masters, Mates and Pilots

National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

American Society of Marine Designers

Secretary—B. G. Barnes, 202 Kendrick Ave., Quincy, Mass.

National Marine Engineers' Beneficial Association

Headquarters 311-315 Machinists Building, Washington, D. C.
Secretary-Treasurer—George A. Grubb.

Atlantic Coast Shipbuilders' Association

1600 Walnut Street, Philadelphia, Pa.
Secretary—C. S. King.

Council of American Shipbuilders, Inc.

30 Church St., New York
President—Homer L. Ferguson.
Secretary-Treasurer—Henry C. Hunter.

American Steamship Owners' Association

11 Broadway, New York
President—Alfred Gilbert Smith.
Vice-President and General Manager—Winthrop L. Marvin.

United States Ship Operators' Association

149 Broadway, New York
President—C. H. Potter.

National Merchant Marine Association

Munsey Bldg., Washington, D. C.
President—Hon. J. E. Ransdell.

The Maritime Association of the Port of New York

78 Broad St., New York City
President—Charles H. Potter.
Secretary—Walter F. Firth.

Lake Carriers' Association

President—Wm. Livingstone, Dime Bank Building, Detroit, Mich.
Secretary—George A. Marr, Rockefeller Building, Cleveland, O.

Neptune Association

21 Pearl St., New York City
Secretary-Treasurer—Captain John F. Milliken.

Ocean Association of Marine Engineers

15 Whitehall St., New York City
Secretary—Bert L. Todd.

CANADA

Grand Council N. A. of M. E. of Canada

Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.

GREAT BRITAIN

Institution of Naval Architects

Adelphi Terrace, London, W. C.

Institution of Engineers and Shipbuilders in Scotland

39 Elmbank Crescent, Glasgow.

Northeast Coast Institution of Engineers and Shipbuilders

Bolbec Hall, Westgate Road, Newcastle-on-Tyne

Institute of Marine Engineers, Incorporated

85/88 The Minories, London, E.1.

ITALY

Collegio Degli Ingegneri Navale e Meccanici in Italia